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ABSTRACT

This study was undertaken to provide a guide to better policy and practice for teachers on the implementation of science and technology education for all by focusing on the role of Science Teachers' Associations (STAS). The study had the following objectives: to survey national policies on science and technology, to identify virile STAS in several countries, to trace the origin and visible role of STAS especially in Africa, to show the relationship of the STAS with the government with respect to formulation of policy about science and technology, to show how national policies get to teachers, to evaluate how well national policies have responded to the felt needs of the African community, and to provide a framework that would lead to science and technology education for all. It was concluded that in general, STAS have been found to influence science and technology education through curriculum development efforts, textual materials production, teacher training programs, and participation in the formulation of science and technology policy. Nine appendices include: a list of African primary science programs, Nigerian core curriculum for primary science, and a list of International Council of Associations for Science Education (ICASE) member organizations. Contains 51 references. (JRH)

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Science, Technology and
Mathematics Education
A Project 2000+ Supplement

ED 390 656

Implementing Science and Technology Education for All: Guide to Better Policy and Practice for Teachers

Ben B Akpan

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1994

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Implementing Science and Technology Education for All: Guide to Better Policy and Practice for Teachers

Ben B Akpan
Administrative Secretary
Science Teachers Association of Nigeria

A Study Commissioned by the
Commonwealth Secretariat
1994

COMMONWEALTH SECRETARIAT

Education Department
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INTRODUCTION

The Science Teachers' Association of any country has a major role to play in the implementation of any science and technology education policy. It is now well known that in the final analysis, it is the classroom teacher who makes or mars any curriculum introduced into the school system. It is therefore vital to carry along the science teachers in this international UNESCO initiative for science and technology education for all popularly known as **Project 2000+.**

This initial study in the series draws heavily on experiences gained in Africa. The continent of Africa prides itself in establishing scientific organisations that provide the meeting point for science and technology teachers across all school levels-primary, secondary and tertiary. The various African governments therefore see these scientific organisations as partners in the arduous task of delivering the science and technology curriculum. In commissioning this and similar studies, we intend to highlight the role which Science Teachers associations have played and will continue to play in **Project 2000+.**

The consultant for this project, Mr Ben Ben Akpan, Administrative Secretary of the Science Teachers Association of Nigeria (STAN) has produced a worth-while document for which I express our thanks and appreciation. While commending this document to Science Teachers Associations, to UNESCO and to ICASE, I would like to state that the views expressed therein are not necessarily those of the Commonwealth Secretariat.

S T Bajah

This study was commissioned by the Education Programme, Commonwealth Secretariat, London, with the following *terms of reference:*

- To survey materials available including national policies on S&T documents.
- To identify virile Science Teachers' Associations (STAS) in several countries.
- To trace the origin and visible role of STAS especially in Africa.
- To show the relationship of the STAS with the machinery of Government with respect to S&T policy formulation.
- To show in logical sequence how national S&T policies get to teachers in the grassroots classrooms.
- To evaluate how well national S&T policies have responded to the felt needs of the African community.
- To provide a Guide Framework which (if followed) can lead to science and technology education for all.

CONTENTS

	Page
Acknowledgement	iv
Abstract	v
Legends	vi
Background	1
National Policies on Science and Technology	4
Science Teachers' Associations (STAs)	10
Role of Science Teachers' Associations	19
Problems Encountered by Science Teachers' Associations	30
Relationship of STAS with the machinery of government with respect to S&T policy formulation	32
How Science and Technology Policies get to Teachers in the grassroots classrooms	35
National Science and Technology Policies and felt needs of the African Community	38
Guide Framework for Science and Technology Education for All	42
Conclusion	46
References	47
Appendices	50

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Mr Anne Hume	—	President, NZSTA
Mr John Ogu	—	General Secretary, STAN
Prof (Sir) J.O.E. Otuka	—	Immediate Past General Secretary, STAN
Dr. O.O. Bello	—	Past General Secretary, STAN
Mr. P.P. Udofia	—	Past Officer, STAN

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Finally, I am indebted to Mr. Abraham Oware, for compusetting the manuscript.

Abstract

This study, undertaken at the instance of the Commonwealth Secretariat in London, sought to provide a guide to better policy and practice for teachers on the implementation of science and technology education for all by focussing on the role of Science Teachers' Associations (STAS). In general, STAS have been found to influence S&T education through curriculum development efforts, textual materials production, teacher training programmes and participation in the formulation of S&T policy. A guide framework has been provided. If followed, the guide could lead to S&T education for all.

Legends

ASE:	Association for Science Education
CASTME:	Commonwealth Association of Science, Technology and Mathematics Educators
COMSEC:	Commonwealth Secretariat
FASE:	Forum of African Science Educators
ICASE:	International Council of Associations for Science Education
IGO:	Intergovernmental Organisation
NGO:	Non-governmental Organisation
NSTA:	National Science Teachers' Association
NZSTA:	New Zealand Science Teachers Association
S&T:	Science and Technology
SEPA:	Science Education Programme for Africa
STA:	Science Teachers' Association
STAN:	Science Teachers Association of Nigeria
STAS:	Science Teachers' Associations
STM:	Science, Technology and Mathematics
STME:	Science, Technology and Mathematics Education
UNESCO:	United Nations Educational, Scientific and Cultural Organisation
WAEC:	West African Examinations Council

Study on Implementing Science and Technology Education for All: Guide to Better Policy and Practice for Teachers

Background

> **Science Teachers' Associations should enter into partnership with the United Nations, Intergovernmental Organisations; participate in programmes on Science and Technology education for all**
>
> *—Project 2000+, International Forum*

The Advisory Committee on the Renewal of Science and Technology Education in Africa (Okebukola, 1993) take *Science and Technology (S&T) education for all* to be the provision of learning experiences in science and technology to the formal school population, the out-of-school population, the work force (including vast number of functional illiterates) the educated adult population, girls and women that are usually marginalised; and people with special needs in the population. These learning experiences in science and technology, according to Okebukola, are in the form of knowledge, attitudes, skills and values and have to be given to all individuals irrespective of state, gender, creed, political affiliation or other peculiarities.

These views are in consonance with those of the participants at the *World Conference on Education for All in Jomtien, Thailand* in 1990. The participants at the conference agreed that basic education was the foundation for lifelong learning and human development. And shortly after the Jomtien Conference, UNESCO in conjunction with the International Council of Associations for Science Education, in recognition of the growing need for a scientifically and technologically literate society, especially its contribution to the enhancement of lifelong education, initiated *Project 2000+*. The three-phased project, now entering Phase III, among others, encourages the formation of national task forces involving personnel from government, IGOs (inter-Governmental organisations) and especially, NGOs (non-governmental organisations such as Science Teachers' Associations) to initiate local programmes for greater scientific and technological literacy.

Against the backdrop of Project 2000+, it should not be an overstatement to say that there is a compelling need to work towards the attainment of scientific and technological literacy for all. However, while S&T illiteracy may be said to

be a global problem, the fact remains that there is a great disparity in the current level of S&T literacy in the various regions with the balance tilting lopsidedly in favour of the developed nations. For example, a survey conducted by UNICEF revealed that in Nigeria (Okebukola, 1993:26):

- 30% of children are unable to attend primary schools for a host of reasons including socio-economic, cultural and difficulty of access of the schools.
- 77% of the pupils lack textbooks including primary science books
- 47% of the school furniture are inadequate for the use of the pupils
- 38% of the classrooms have no ceiling
- 36% of the pupils have no writing materials
- 3% of the schools have no chalkboard
- 12% of the pupils sit on the floor for lessons
- 31% of the teachers observed used no teaching aids
- 80% of the schools have no equipment and materials for teaching primary science.

But if in their present state, the developed nations are conscientiously pursuing programmes that will lead to further increase in the level of S&T literacy, this should be a 'food for thought' for the developing nations, particularly those in Africa. This concern has been expressed in a number of quarters. For example, while delivering a public lecture at the 33rd Annual conference of the Science Teachers Association of Nigeria, Bajah (1992:17) lamented:

> My burning concern now is what will be facing humanity at the turn of the century, and how well we in Nigeria will prepare the young ones to face a world in which human beings will be competing with robots. Trips to outer space will be common place in some parts of the developed world. The computer will organise our work as well as our play ... This is the time to begin to plan ahead so that we can avoid our age-old 'Fire Brigade Approach'.

Prof. Sam Bajah was not alone with this view at the said conference. In fact, delegates to the ICASE/UNESCO/STAN seminar held as a feeder meeting to phase 1 of *Project 2000+* as part of the 33rd Annual Conference of STAN were not enthused over the existing level of S&T literacy in Nigeria in particular and Africa in general. Expectedly, STAN proposed a target date of 2057 for the attainment of the goals of project 2000+ in Nigeria (the date coincides with the centenary celebration of the founding of STAN). Similarly, African delegates to the International Forum of Project 2000+ in Paris France, July 5–10, 1993, agreed to form *national task forces* for the prosecution of the ideals of the project. In Nigeria, the proposal for the formation of the task force anchored by the STAN President Prof. Uduogie Ivowi, is currently receiving the attention of government.

Of particular significance is the *Declaration* by the participants in the

international forum of Project 2000+ *urging* non-governmental organisations such as *Science Teachers' Associations to:*

- enter into partnership with, and make their knowledge and experience available to, United Nations and other inter-governmental bodies as well as establish innovative programmes in a common effort to achieve the goal of scientific literacy and technological literacy for all; and
- participate in national, regional and international programmes for the enhancement of scientific and technological literacy for the improvement of the quality of life in all societies and for the achievement of sustainable development.

It is this aspect of the *Declaration* (Appendix A), that forms the pivot of this study. Thus while there is a general consideration of the tenets of scientific and technological literacy, particular cognisance has been taken of the role which science Teachers' Associations (STAS) could play. Similarly, and understandably, much of the focus is on Africa.

National Policies on Science and Technology

Disparities are discernible in national S&T policies. Even so, in Africa, the *African Primary Science Programme* set the pace, leading to integrated approach to S&T teaching in many countries

Science and Technology (S&T) have consistently been given prominence in the educational policies of most countries. A survey conducted by the United Nations Educational, Scientific and Cultural Organisation (UNESCO, 1986) has shown that science, technology and mathematics are taught in the schools by several nations though to varying degrees.

Table 1 provides an overview of the percentage of time allotted for science and mathematics in school curricula. Some disparities are discernible. For example, Sierra Leone allocates a dismal 11.3% for Grades 1–2 compared to the averages of 27.4 and 29.2 for Africa and the world respectively.

Table 1
Percentage of time allotted to Science and Mathematics in school curricular

	Grades 1–2	Grades 3–6	Grades 7–9
Botswana	23.5	23.4	27.1
Ethiopia	26.5	26.5	26.0
Ghana	25.4	25.4	23.7
Kenya	17.1	24.8	29.6
Lesotho	19.0	23.4	44.6
Mauritius	20.5	19.0	39.7
Nigeria	39.1	36.3	22.8
Seychelles	26.2	25.5	37.2
Sierra Leone	11.3	18.8	25.9
Tanzania	30.0	25.4	33.3
Zambia	25.7	26.9	26.9
Africa	27.4	30.8	37.0
Arab States	23.8	24.7	26.8
Asia and the Pacific	31.4	27.4	35.9
Europe	30.8	30.9	37.1
Latin America and the Carribbean	30.0	32.7	39.3
World	29.2	29.9	36.3

Source: Adapted from UNESCO (1986)

In Africa, a lot of input was created by the African Primary Science Programme (APSP) and the African Mathematics Programme (AMP). Both Projects were initiated by the Educational Services Incorporated (ESP which later became known as the Education Development Centre, EDC) based in Newton, Massachusetts, U.S.A. Urevbu (1990) reports that the two projects were offshoots of the famous summer study in African Education at the Massachusetts Institute of Technology in 1961.

The African Mathematics Programme, funded by USAID and Ford Foundation, aimed at improving the quality of mathematics teaching and to develop in each participating country a nucleus of people knowledgeable in mathematics and capable of undertaking improvement of mathematics curriculum. By 1969, the AMP had produced a complete textbook series from Primary one to primary seven (Pupils books and accompanying teachers' guides); a manual for teacher training, basic concepts in mathematics and two alternative series for secondary schools — 67 volumes of prototype materials. The series have been criticised for heavy reliance on language (particularly descriptive terminology), a constant pre-occupation with classroom and textbook centred examples at the expense of using the rich mathematical resources in the immediate environment, as well as the rigid, class by class progression of texts. The series were used in several English speaking countries including Nigeria.

The African Primary Science Programme (APSP) on the other hand was initiated in February 1965 at Kano, Nigeria. Like the AMP, the APSP was funded by the USAID and the Ford Foundation. It aimed to enable the African child to:

- be familiar with a variety of biological, physical and man-made phenomena in the world around him;
- show interest in further exploration of the world around him on his own initiative;
- acquire ability to find out for himself — to see problems and to be able to set about resolving it for himself;
- demonstrate confidence in his own ability to find out for himself and do things for himself;
- acquire ability to share in a common development of knowledge (SEPA, 1975 in Urevbu, 1990).

By 1970, the APSP was able to produce fifty units, six films and some apparatus. Appendix B lists some of the titles produced by APSP.

However, the management of the APSP was in 1970 taken over by eleven participating governments under the auspices of the Science Education Programme for Africa (SEPA) with headquarters in Accra, Ghana (Yoloye, 1978). Participating countries in SEPA included Botswana, The Gambia, Ghana, Ethiopia, Kenya, Lesotho, Liberia, Malawi, Nigeria, Sierra Leone, Tanzania, Swaziland, Uganda and Zambia. SEPA was funded by African Governments, USAID, UNESCO and Carnegie Corporation of New York. The objectives of SEPA included:

- facilitation of excellence and relevance in the learning of science at all educational levels in Africa;
- development of manpower resources in science curriculum development;
- development of instructional material for teacher training institutions and for schools;
- promotion of information exchange.

SEPA's approach to science education took the view that science is a medium through which a child might develop his natural curiosity, his powers of observation and enquiry, and constructive attitudes to problem-solving and decision. In its handbook for teachers of science (Appendix C), SEPA (1978) places a high premium on integration.

It is therefore not unexpected that even though SEPA is virtually moribund, the current approach to primary science in most African countries as Chisman (1988) reports, is, invariably an integrated one — a reflection of the philosophy and practice of the Science Education Programme for Africa (SEPA). In fact, Chisman contends that some of the original units and teaching materials are still in use as part of the primary school courses in some countries. This has necessitated an overview of current science education policies in a few countries in Africa, namely, Ghana, Nigeria and Zambia.

Ghana

The current Education system for Ghana which came into effect in 1986, provides for a nine-year basic First Cycle education made up of six years primary plus three-years Junior Secondary, compulsory for all children of school-going age. The second cycle appears only in one phase, the three year senior secondary school, while the third cycle includes the universities, polytechnics and diploma colleges (see Appendix D).

A spiral primary science curriculum has been designed with the aim, among others, of providing an atmosphere in which pupils are sufficiently stimulated and encouraged to become well informed, capable of using their hands and of doing clear logical thinking. According to Ajeyalemi (1990), the Junior Secondary School Science syllabus, developed in 1987, provides a system of science course such that all pupils, whatever their academic abilities and career intentions, receive an appropriate science education.

In Ghanaian Secondary Schools (Second Cycle) General Integrated Science is a compulsory subject. Other subjects include Biology, Chemistry, Physics, General Science, Additional General Science, Agricultural Science, Home Science (Home Economics) and Health Science, out of which a student can select two in the last three years of secondary education. Ajeyalemi (1990) has reported that the course contents for these subjects are defined by syllabuses issued by the West African Examinations Council (WAEC) which has imposed conditions to ensure practical orientation of the science courses.

Tertiary (Third Cycle) institutions prepare science teachers, engineers, agriculturists, medical officers and scientists with most programmes modelled after those in British universities, for obvious reasons.

Junior Secondary Schools teach technology in order to promote skills that will familiarise the students with technology, science and various vocations (Ministry of Education, and Culture, Ghana, 1987). At the secondary level, objective of technology education include the production of skilled, middle-level manpower for industry and commerce. Technical education at the tertiary level is carried out in the University of Science and Technology, Kumasi and the polytechnics.

Nigeria

Nigeria runs a 6-3-3-4 system of education (Appendix E) anchored on the need to integrate the individual into a sound and effective citizen and the provision of equal educational opportunities for all citizens at the primary, secondary and tertiary levels, both inside and outside the formal school system (Federal Republic of Nigeria, 1981). Some of the general objectives of primary education are:

- the inculcation of permanent literacy and numeracy, and the ability to communication effectively;
- the laying of a sound basis for scientific and reflective thinking
- developing in the child the ability to adapt to his changing environment;
- giving the child opportunities for developing manipulative skills that will enable him to function effectively in the society within the limits of his capacity.

A core curriculum for primary science (see Appendix F) has been developed with the objectives of enabling the Nigerian child to:

- observe and explore the environment;
- develop basic science process skills, including observing, collecting, manipulating, classifying, communicating, inferring, hypothesizing, interpreting data and formulating models;
- develop functional knowledge of science concepts and principles;
- explain simple natural phenomena;
- develop a scientific attitude, including critical reflection and objectivity;
- apply the skills and knowledge gained through science to solving everyday problems in his environment;
- develop self confidence and self-reliance through problem solving activities in science;
- develop a functional awareness of and sensitivity to the orderliness and beauty in nature (Federal Ministry of Education, 1981(a):8).

At the Junior Secondary level, Integrated Science is a compulsory subject. The core curriculum for integrated science (Federal Ministry of Education, 1981(b):3) adopts a *thematic* approach and is aimed at enabling the pupils to acquire the following skills:

(i) Observing carefully and thoroughly.

(ii) Reporting completely and accurately what is observed.

(iii) Organising information acquired.

(iv) Generalising on the basis of acquired information.

(v) Predicting as a result of of the generalisations.

(vi) Designing experiments (including controls where necessary) to check predictions.

(vii) Using models to explain phenomena where appropriate.

(viii) Continuing the process of inquiry when new data do not conform to predictions.

Introductory technology is also taught in the Junior Secondary.

At the Senior Secondary level, science is taught as separate subjects of Agricultural Science, Biology, Chemistry and Physics. Mathematics and technical subjects are also taught. The Physics curriculum for Senior Secondary Schools, for instance aims, among others, at providing the student with basic literacy in physics for functional living in society.

A national Agency that co-ordinates all curriculum development efforts, *The Nigerian Educational Research and Development Council (NERDC)* was established in 1988 through a merger of four bodies — the Nigerian Educational Research Council (NERC), the Comparative Education study and Adaptation Centre (CESAC), the Nigerian Book Development Council (NBDC) and the Nigerian Language Centre (NLC).

In addition to the curriculum documents, Nigeria has two other important documents on S&T. These are the *National Policy on Science and Technology* as well as the *National Policy on Science and Engineering Infrastructure.* The objectives of the Nigerian Science and Technology Policy (Federal Republic Nigeria, 1986:10) are to:

- increase public awareness in S&T and their vital role in national development and well-being;
- direct S&T efforts along identified national goals;
- promote the translation of S&T results into actual goods and services;
- create increasing and maintain an indigenous S&T base through research development;
- motivate creative output in S&T;
- increase and strengthen theoretical and practical scientific base in the society; and
- increase and strengthen the technological base of the nation.

On the other hand, the National Policy on Science and Engineering Infrastructure (Federal Republic of Nigeria, 1992) provides for the prosecution of a Science and Engineering Infrastructure Development Programme (S-EIDP) aimed at catalysing the emergence of endogenous capacity able to supply a progressively increasing percentage of delivery/production systems needed to support the efficient production of goods and services locally. Consequently, a National Agency for Science and Engineering Infrastructure (NASENI) has been established. In the implementation by NASENI of its science and engineering infrastructure development mandate, four subjects have continuously attracted attention, namely:

- manpower development;
- science, engineering, and technology information services;
- science and engineering infrastructure development complexes; and
- independent infrastructural industries.

Zambia

In Zambia, the aim of education is to develop the potential of each citizen to the full for his own well being as well as that of society and for selfless service to his fellow men. Consequently, the nation's Educational Reform Document (Ministry of Education, Youth and Sports, Zambia, 1977) provides for a three-stage structure of education, namely:

- Basic education in grades 1–9.
- Second stage education — secondary school (vocational training) 3 years.
- Third stage education.

The Reform Document also provides for a basic science education that will enable the pupil to master useful practical skills which they would apply in life in various ways, adopt a scientific approach and attitude, observe, collect information, draw conclusions and apply what they know. A new environmental Science syllabus which forms an integrated course of science for grades 1–9 has replaced the old syllabuses of primary science and junior secondary science. Science courses are also taught in the secondary schools while technology education takes place mainly in institutions of higher learning. A British Council project — the Zambia Mathematics and Science Teacher Education Project (ZAMSTEP) — has helped in no small measure in science teacher training. ZAMSTEP provides, among others, a secondary science and mathematics upgrading programme, open to teachers with college Diplomas plus at least five years teaching experience.

Of special significance is the role of the Junior Engineers, Technicians and Scientists (JETS) of Zambia. Established in 1966, the main objectives of JETS include the popularisation of science and technology among secondary school pupils. In pursuance of this, JETS clubs hare been established in secondary and primary schools. A 'JETS and, of, ZAMBIA' magazine has also been published.

Science Teachers' Associations (STAS)

The NSTA, ASE are the leading STAS in the world. However, in Africa, STAN is the most virile STA, being the only STA in the region to have a permanent Secretariat

Worldwide, Science Teachers' Associations (STAS) have played significant roles in STME. However, before a more detailed consideration of the role of STAS (especially in Africa) can be made, it would be necessary to provide brief profiles of some STAS. A comprehensive list of STAS is given in Appendix G.

National Science Teachers Association, U.S.A.

The National Science Teachers Association (NSTA) is the largest non-profit educational organisation in the world dedicated to improving science education at all levels — preschool through college. Founded in 1944, NSTA has a membership of about 50,000 which includes science teachers, science supervisors, administrators, scientists, business and industry representatives, and others involved in science education. NSTA offers the following services: four journals *(Science and Children, Science Scope, The Science Teacher and The Journal of College Science Teaching)*, a newspaper *(NSTA Reports!)*, regional and national conventions, awards programmes, teacher training workshops, educational tours, an employment registry, professional certification, and position statements on a variety of science education issues. The Association has, for instance, published a *Lead paper on Science and Technology Education for the 21st century.* The Association believes that (a) scientific literacy must be a major goal of science education worldwide and for all children and (b) national and international professional organisations and agencies and institutions must work together to ensure effective science teaching around the world (NSTA, 1990).

To exchange ideas with international colleagues, NSTA held its first international conference in Moscow in 1991 and the second international conference near Mexico city in 1993. NSTA and it British counterpart, the Association for science Education, conduct a lecture exchange each year. In addition, NSTA has special representatives serving on the Executive Committee of ICASE. NSTA staff and members attend conferences and meetings of science and/or education organisations, institutions, and agencies around the world. It welcomes international members and invites international colleagues to attend its conventions. The NSTA has set up task forces on:

- Articulation with school Administrators.

- Child Advocacy.
- Developing a Research Agenda.
- Developing a Science Education Research Database for teachers.
- Developing School Science Standards.
- Developing standards for identification of courses for science credit.
- Elementary Scope, Sequence and Co-ordination Project Development.
- An Expanded view of Assessment .
- NSTA/NCTM Areas of Co-ordination
- NSTA Sponsored sessions at Non-NSTA Conventions/Meetings.
- NSTA visions for the 1990's and beyond.
- Past Presidents.
- Science Teacher Professionalisation.

According to NSTA (1993b) of the Association was expected to have purchased a new headquarters building in Arlington, Virginia, a suburb of Washington DC, by June 1993. The four storey red brick office building, located at 1840 Wilson Boulevard costs US $5.45 million. The building offers a three-level underground parking garage for 138 vehicles and outside parking for 16 vehicles. At present, NSTA plans to occupy all of the third floor and parts of the first and second floors. The remaining space will be rented to tenants. NSTA is purchasing the building to consolidate all of its operations — once scattered in three locations and later at two facilities in Washington, D.C., and Arlington, Virginia — into one building.

The NSTA headquarters is headed by an Executive Director. The Association has a Board of Directors with the President serving for one year — two other years as elect- and retiring-. There are Directors for the following Divisions: Preschool and Elementary School, Middle level, High School, College, Research, Supervision, Teacher Education, and Multicultural Education.

Association for Science Education, United Kingdom

The Association for Science Education (ASE) located at College Lane, Halfield, Herts, U.K., was constituted under a Trust Deed dated 5 January, 1963. The objects of the Association are to promote education by:

- improving the teaching of science;
- providing an authoritative medium through which opinions of teachers of science may be expressed on educational matters;
- affording means of communication among all persons and bodies of persons concerned with the teaching of science in particular and with education in general.

The ASE is governed by a council comprising: Association chair, Regional representatives, Immediate Past chair, Chair-elect, Active Trustee, Treasurer, 4

co-opted members and the General Secretary (in attendance). The General Secretary, a full time employee, represents the Association nationally and liaises with a wide range of similar professional Associations and industrial and commercial organisations. He is responsible to Council for the day-to-day running of the Association.

The Association has three groups — interest, service and tasks groups — working independently to advance the aims of the Association. Interest groups (e.g. Science Advisory Teachers Group) support the interest of sub-sets of members with a self-defined brief, but to the mutual advantages of the Group and the Association. Service groups (e.g. The Primary Science Committee), are established by the Association to provide a continuing contribution towards its (ASE'S) work and effectiveness. Task Groups (e.g. Post-16 Working Party) are established by the ASE to tackle a clearly defined task.

The ASE has a number of periodicals. These include the *School Science Review, Primary Science* and *Education In Science.* It also has an insurance scheme which protects individual members in the U.K. against any civil action taken against them in the courts for the death of, or injury to, any person and loss of, or damage to, property either happening, or caused, during the performance of members' professional duties. In terms of scope of activities, the ASE is indeed, a model in Europe and second only to the Washington, D.C.-based NSTA in the world.

Science Teachers Association of Nigeria (STAN)

Established on 21 June 1957, STAN has the following aims:

- To promote co-operation among science teachers in Nigeria with a view to raising the standard of science education in the country.
- To provide a forum for discussion by science teachers on matters of common interest.
- To help science teachers keep in touch with developments in science and its applications to industry and commerce.
- To popularise science.
- To co-operate with and affiliate to other societies and bodies with related interest.

The functions of the Association which has about 1000 members include the following:

- Encouragement of the interchange of ideas among science teachers through meetings, conferences, workshops (see Appendix H for schedule of workshops for 1994), exhibition of science materials, books and periodicals.
- The publication of the Journal of STAN, position papers, STAN bulletin and conference proceedings.
- Interaction with all bodies concerned with science and science education.

STAN is administered by three separate but mutually supportive organs: the Annual General Meeting, The Governing Council and the National Executive Committee (STAN, 1991). It has ten subject panels: Agricultural Science, Biology, Chemistry, Integrated Science, Mathematics, Physics, Primary Science, Science, Technology & Society, Teacher Education and Technology Education. There is a branch in each of the nation's 30 States as well as a Federal Capital territory branch. The Association maintains a Secretariat at the premises of Government College, Ibadan, Oyo State headed by a full-time Administrative Secretary whose functions include, among others, the effective day-to-day running of the Secretariat and keeping the Association's books and records. Though its Secretariat is yet to be fully equipped, STAN is the only STA in Africa "with a permanent Secretariat and vehicles, and it's been a leading light in the various attempts to develop an African super-association, its publications, courses and conferences being highly regarded" (Deeson, 1993:1). The African Forum for children's Literacy in Science and Technology, in the May 1992 edition of its newsletter also describes STAN as a 'successful model'.

Ghana Association of Science Teachers (GAST)

GAST was formed in 1956 to promote science teaching in Ghana. The Association has a number of subject Panels (Biology, Chemistry, Elementary Science, Junior Secondary School, Laboratory Technicians, Physics, and Teacher Training). It also has regional groupings: Brong-Ahafo, Central, Greater Accra/Eastern, Northern, Upper East, Upper West, Volta and Western Region. Each region has its offices but overall co-ordination is the responsibility of a national executive comprising President, Secretary, Assistant Secretary (2), Treasurer, Public Relations Officer, Science Fair Organiser, Immediate Past President, Curriculum Review and Development Chairman, Chairman, Publication Committee and Chairman, Instructional Materials and Equipment Committee. There are no full-time staff and no permanent Secretariat.

Zambia Association for Science Education (ZASE)

ZASE was inaugurated in 1966 with the task of improving the teaching of science in schools. It has published teaching notes for teachers and has compiled a large stock of examination papers. It organises conferences where exhibition of laboratory equipment and books is carried out. However, its bid to buy a group insurance for members failed due to non-payment of dues by members. Still, ZASE has made immense input through its involvement in the activities of the JETS of Zambia and in some international activities such as the 1st African Sub-Regional Science Olympiad held in Lusaka, Zambia in 1990. Its inability to establish a permanent secretariat has meant that much of its activities revolve around personalities. The ICASE Secretariat for instance, has lost contact (temporarily?) with ZASE following the death of the Secretary General of ZASE Mr. T. Varghese.

New Zealand Science Teachers Association (NZSTA)

NZSTA is a national organisation made up of 15 regional Science Teachers' Associations under the leadership of a national executive elected for a period of two years. It is committed to:

- providing information and advise to teachers of science on resources, teaching methods and curriculum;
- promoting the development of effective links between teachers of science in primary, intermediate, and secondary schools, to enhance the quality of learning in science at all levels.

The NZSTA has a Working Party developing guidelines for Professional Standards and negotiating a contract with the Ministry of Education to set up Professional Standards for Science Teachers. It is also developing teaching resources to complement the new science curriculum. According to Anne Hume, the President of NZSTA, this is their first commercial activity. He is hopeful of expanding the area in future. At the 1993 AGM, the NZSTA voted to form a National Executive with a permanent paid Secretariat. It has the support of the Royal Society of New Zealand in this regard. The NZSTA is a member of the Society. It publishes a journal *NZ Science Teacher* three times a year and a newsletter about five times a year. Biennial conferences are also organised. The membership of the NZSTA is about 500.

Science Teachers Association of Singapore

The Association was formed in 1965. It is an Association for science and mathematics teachers and has seven subject committees — biology, chemistry, physics, general science, maths (primary), maths (secondary) and science (primary). Recent publications include a handbook of practical activities in Biology (plus slides); Chemistry board games; a booklet on process skills test items for primary schools. The Association produces yearly three issues of its bulletin and its journal *SCIENTAS*. Activities include involvement in the Singapore science fortnight with Science Centres and especially the science camp and science fair, Primary Science Club activities (young scientist badge award scheme) and Questa (for secondary school students). It is involved with subject curriculum committees and contributes to the primary and lower secondary subject groups. It is involved in vetting science materials for schools. The Association raised the idea of making senior science teachers hold positions of Head of Department which was implemented in 1985. It assists in courses for teachers.

Sri Lankan Association of Science and Mathematics Educators (SLASME)

SLASME was formed in 1984 to develop and improve the quality of science education in Sri Lanka, to share knowledge and trends in science and science

education, provide a forum for people of similar interests to meet and have fellowship. The Association is not currently involved in curriculum development, but is able to put suggestions to the Ministry of education e.g. introduction of continuous assessment in Sri Lanka. Activities include a regular newsletter 4 times a year, meetings 3 times per year (in a rural area) and committee meetings every month (in Kandy or Colombo). There is emphasis on increasing membership by getting media to help publicise the annual meeting. SLASME is also involved in supplying materials for a weekly commercial science newspaper.

Hong Kong Association of Science and Mathematics Educators (HKASME)

HKASME was founded in 1964 to promote science and mathematics education in Hong Kong. Its membership is about 1000 and is affiliated to the Association for Science Education in the United Kingdom. Its aims are to improve the quality of science and mathematics education, to provide a means of communication for science and mathematics teachers, provide a medium for teacher to express opinions and extend the professionalisation of teachers. Activities include lectures, seminars, workshops and field trips. It also sells low cost equipment, publishes a newsletter monthly and a journal twice per year. It is heavily involved with the work of the curriculum development committee (CDC) and the Hong Kong Examinations Authority (HKEA). Special functions include an annual conference each June.

Nepal Science Education Society (NESES)

The NESES was established in 1991 as a non-profit organisation of science teacher educators, science teachers and those interested in the dissemination, promotion and innovation of science education in Nepal. NESES aims to promote and propagate the teaching and learning of Science from primary to higher education, to disseminate the importance of science education, to promote the exchange of innovative ideas among member institutions, to develop co-operation among those involved in science education, and to contribute to science education policies, planning, implementation and evaluation.

Brunei Association of Science Educators (BASE)

BASE was formed in 1977 and its activities can be divided into 2 parts; those for teachers and those for students. For teachers, BASE organises seminars, workshops, talks, courses (e.g. on computers). The main target has been secondary school teachers, but more emphasis is now being placed on helping primary teachers. For students, a number of activities are organised e.g. the science project competition, the science quiz and a 3D art photo competition. BASE publishes a journal once per year (if possible) and a newsletter 3 times per year.

Korean Science Education Association (KSEA)

KSEA was formed in 1970. It holds national conventions twice each year, one in the summer vacation and the other in the winter vacation. Science educators are sometimes invited from foreign countries. In the summer, a science camp is also organised for teachers to exchange ideas on science teaching. Students also attend the science camps.

Umbrella Organisations

Apart from the Science Teachers' Association listed above, there are a number of regional and international organisations which have contributed immensely to STM education. These include the:

West African Association of Science Educators (WAAST)

WAAST was established in 1977 to, among others, establish an all-embracing Union of the STAS in West Africa with a view to promoting interchange of information and ideas about professional matters. The Association became inactive after a few years due to lack of funds.

Forum of African Science Educators (FASE)

FASE was inaugurated in Lagos, Nigeria in 1980 under the auspices of the Science Teachers Association of Nigeria. It sought to:

- promote co-operation among STAS in Africa.
- encourage the formation of STAS in Africa.
- promote good science teaching in schools in Africa.
- co-operate and/or affiliate with any organisation whose aims and objectives are in accord with the above objectives.

Now becoming virtually moribund, FASE drew its membership from STAS in Botswana Ethiopia, Gambia, Ghana, Kenya, Lesotho, Malawi, Nigeria, Sierra Leone, Swaziland, Tanzania, Uganda, Zambia and Zimbabwe. Its President is still Prof. O.C. Nwana, a consultant with the Nigerian Educational Research and Development Council, Abuja. However, there is yet no replacement for its late Secretary General/Treasurer Mr. Thomas Varghese of Kitwe, Zambia.

The experience of FASE (and to some extent WAAST) is a sad one. Its activities are virtually paralysed due to financial constraints.

African Network for Research and Development in Science and Technology Education (ANERSTE)

ANERSTE was formed in January, 1993 by African delegates who attended an international conference in Israel. Immediate activities of the Network include publication of the *ARNESTE Newsletter* and *Who's Who in Science and Technology Education in Africa.* The group met again in Paris, France, in July, 1993 during the

International Forum of Project 2000+ and informed delegates about its progress so far.

African Forum For Children's Literacy in Science and Technology

This *Forum* is an informal association of African educators, scientists, technologists, media specialists and international resource people. It is financed and supported by the *Rockefeller Foundation.* The Forum has an Advisory Board that overseas policy, and a Grants Committee which recommends proposals to the Rockefeller Foundation. Its Secretariat is housed in the Regional Rockefeller Foundation office in Nairobi, Kenya.

The Secretariat solicits proposals and recommends them for peer review before presentation to the Grants Committee. A *resource bank* is being established at the Secretariat for use by science educators throughout the continent. The Forum has for example, given a grant to the *Lesotho Science and Mathematics Teachers Association* to publish its journal for a year.

Commonwealth Association of Science, Technology and Mathematics Educators (CASTME)

Inaugurated in 1974, CASTME is supported and funded by the Commonwealth Foundation, Commonwealth Secretariat, Marlborough House, Pall Mall, London. It has a Council headed by a Chairman with the Chief Programme Officer (STME) at the Commonwealth Secretariat as the Honorary Secretary. *CASTME* has an *awards scheme* which is intended to encourage teaching of the social aspects of STM with particular reference to third world countries in the Commonwealth. The scope of the awards is interpreted broadly and the phrase 'social aspects' includes the relevance of the STM curricula to local needs and conditions and also to the impact of technology, industry and agriculture on the local community. According to CASTME (1992), its strength lies in its ability to attract the commitment of specialists from all parts of the world.

International Council of Associations for Science Education (ICASE)

ICASE was established in 1993 to extend and improve education in S&T for all children and youth throughout the world by assisting STAS that are members. It is particularly concerned in providing a means of communication among individual STAS and to foster co-operative efforts to improve S&T education. Activities of ICASE include:

- publishing a journal *Science Education International;*
- issuing a *Directory* of STAS worldwide
- publishing the *Who's Who in STM Education around the world;*
- disseminating information about activities of national and regional groups;
- arranging regional activities in association with other organisations such as UNESCO;

- promoting exchanges of science personnel;
- using its endeavours to promote research in science education.

The Governing body of ICASE is the General Assembly consisting of one delegate from each member Association together with any members of the Executive Committee who are not delegates. The Executive Committee comprises President, Past-President, President-elect, and up to eight members elected on a geographical basis. The Executive Secretary, Treasurer and Editor are appointed by the Executive Committee. ICASE is financed, in part, by annual fees from member associations, institutions, foundations, and companies. But because it is *not a Foundation* (and is *not* funded directly by any Foundation), *it has no means of assisting member associations financially.* ICASE has no permanent Secretariat. The full list of member associations as of August, 1993 is as shown in Appendix G.

Role of Science Teachers' Associations

> **A powerful kind of organisation that stimulated development in science education in practically all the countries was the association of science teachers. Everyone of the countries studied had such an association in one form or another. There were variations in the magnitude of contributions made by these organisations from country to country.**
>
> ***— Bajah and Yoloye (1981)***

As earlier stated, Science Teachers' Associations (STAS) have been known to play significant roles in STME. Silber (in King 1991:47) sees STAS as performing the following functions:

- Communications — Journals, conferences, publications.
- Representation — To teachers and government, liaison with other groups and participations in international activities.
- Services — continuing education, employment, low cost equipment and out-of-school activities.
- Leadership — Curriculum development, teacher benefit, guidance on new developments in science education.

In fact, STAS such as NSTA and ASE have had tremendous influence on STM education not only in their countries but also in foreign nations. For instance, Holbrook and Chisman (1988) report that in the U.K. the ASE was responsible for producing *Science in Society* and *Science in a Social Context* courses.

In *Africa,* Bajah & Yoloye (1981:27) while evaluating *Science Education Programme for Africa* had this to say:

> A powerful kind of organisation that stimulated development in science education in practically all the countries was the association of science teachers. Everyone of the countries studied had such an association in one form or another. There were variations in the magnitude of contributions made by these organisations from country to country. Gambia, Liberia and Lesotho report negligible contribution. At the other end the Ghanaian and Nigerian associations have exerted tremendous influence on the training of science teachers, the curriculum, and educational policies. STAN in Nigeria, produced its own books in integrated science for the first two years of secondary schools.

Others (Sharma, 1974; Bajah, 1983; Dienye and Gbamanja, 1990; King, 1991) are in general agreement with the above assertion. According to King, the achievement of STAN in the pursuit of quality education in science in Nigeria is a record of which it should be justly proud. This is because, STAN has produced curriculum materials and support textbooks which have gone a long way towards the establishment and maintenance of STM.

In general, the STAS in Africa have made contributions in STME in the following areas:

(a) Curriculum Development

STAN is probably the leader in this respect. In 1968, a request was made to STAN by the west African Examinations Council (WAEC) to make recommendations on the review and improvement of the then GCE 'O' level science syllabuses. A revision was thought necessary due to developments in science education all over the world. Consequently, STAN set up four curriculum development committees, one each in Biology, Chemistry, Physics and Mathematics. The project was funded by the *Ford Foundation* (through the Comparative Education study and Adaptation Centre CESAC), *Curriculum Renewal and Educational Development Overseas* (CREDO) through the British Council. Support in the form of curriculum materials was received from UNESCO and from Longman (Nigeria) publishing company.

Later on, additional Committee was set up to take care of integrated science. The publication of Curriculum Development Newsletter No.1 (STAN, 1970a) meant that things could not be the same again in Nigeria with respect to science teaching. In a *Foreword* to the newsletter, the then General secretary of STAN Rev. P.S. Samuel (STAN 1970a:3) said, inter alia:

> The need for curriculum Reform in Science Education in Nigeria has been felt by the members of the Association for some time and especially since the great Curriculum Reform movements, such as B.S.C.S., P.S.S.C., Chemstudy and C.B.A. in the United States, the Nuffield Teaching Project in the United Kingdom and the work of the Scottish Education Department, began to influence the general educational atmosphere everywhere. However, professional associations are seldom strong enough financially or sufficiently strong enough to carry out such important task alone. The Science Teachers Association of Nigeria nevertheless felt that it was time to do something about the development of a new science teaching curriculum for our schools ... We hope that this is the beginning of a long and important process and we invite comments, criticisms and suggestions on the contents of our work so that we may improve upon it in future. With this hope and prayer, we present the first *fruits* of our Curriculum Development work to teachers and other science educators.

The document proposed that the integrated science course should enable the Nigerian child to:

- be *actively involved* in the learning process;
- develop the motivation and ability to work and think in an *independent fashion;*
- *recall* information and experiences;
- *devise* schemes for solving problems;
- *use* and classify given information;
- *apply* previous knowledge to new situation;
- *interpret* information showing evidence of *judgement* and *assessment.*
- *Communicate* selectively and effectively.
- *relate* his experiences in each subject area to other areas and to live in his society.

Accordingly, the course envisaged that the following skills would be acquired by the child:

- *Observing* carefully and thoroughly.
- *Reporting* completely and accurately what is observed.
- *Organising* information acquired by the above process.
- *Generalising* on the basis of acquired information.
- *Predicting* as a result of these generalisations.
- *Designing* experiments (including controls where necessary) to *check* these predictions.
- *Using models* to explain phenomena where appropriate.
- *Continuing the process* of inquiry when new data do not conform to predictions.

The course, initially planned for two years (Fig. 1), is now a three-year course following the introduction of the 6-3-3-4 system of education in Nigeria. The present course has the following themes:

- You as a living thing.
- You and your home.
- Living components of the environment.
- Saving your energy.
- Controlling the environment.

A spiral arrangement is adopted for each theme.

Following the publication of the Curriculum Development Newsletter No. 1, three others were subsequently published:

- Curriculum Development Newsletter No. 2: Chemistry Syllabus (STAN, 1970b).
- Curriculum Development Newsletter No. 3: Biology Syllabus (STAN, 1971a).

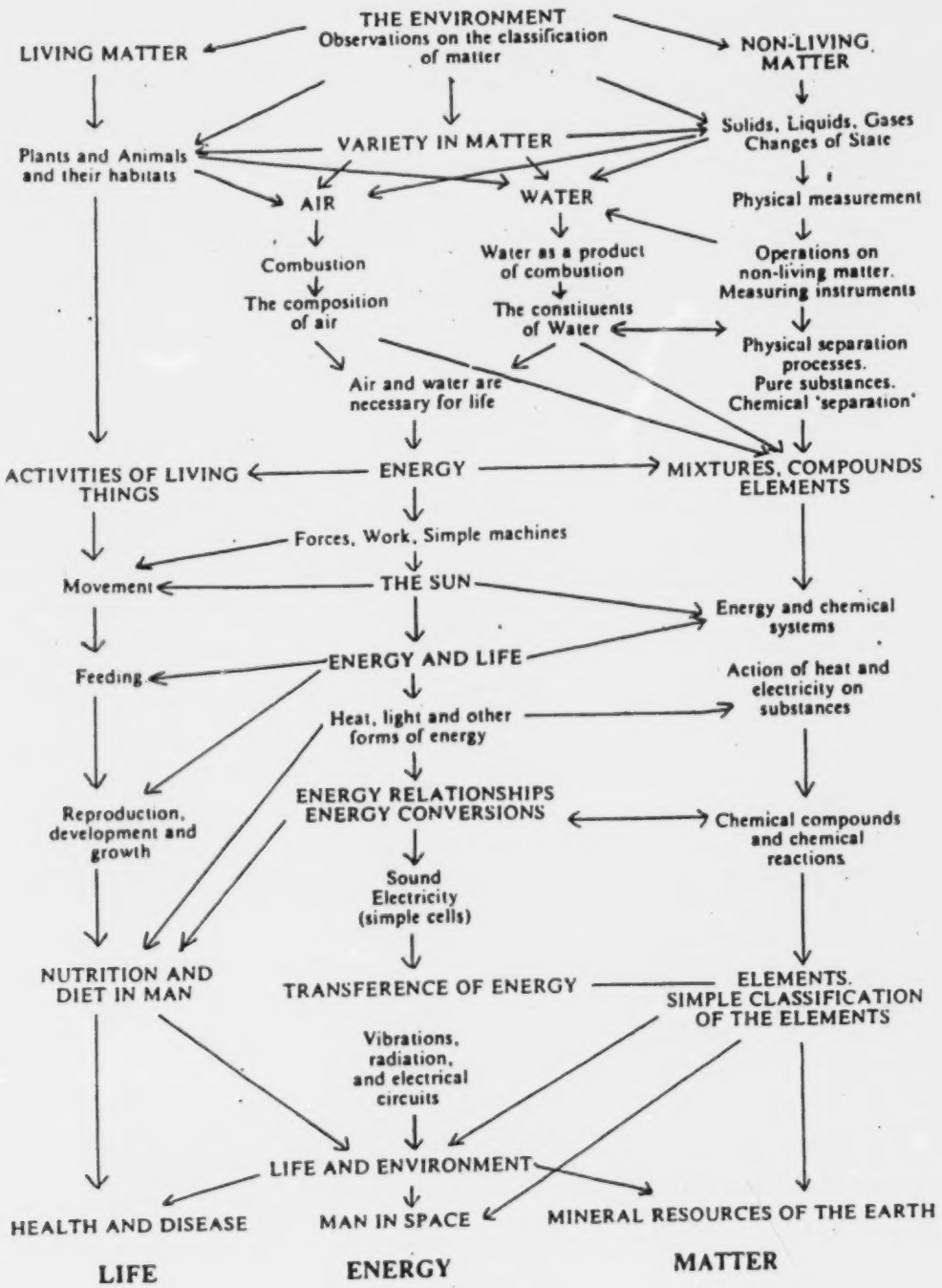

Fig. 1: **Integrated Science: A course for the first two years of Nigerian Secondary Schools**
A Flow Chart of the Outline Content

- Curriculum Development Newsletter No. 4: Physics Syllabus (STAN, 1972).

These Curriculum Newsletters produced new syllabuses for Chemistry, Biology and Physics. The curricula were teaching syllabuses which were completely different in content and format from the WAEC Examination Syllabuses in use at the time. According to Otuka (1993), at the inception of the 6-3-3-4 system, the Federal Ministry of Education embarked on streamlining the existing curricula in use in all schools so as to produce a single national curriculum content in each science subject. It is to the credit of STAN that some of its members served as resource persons during the exercise in 1984 and 1985.

The current syllabuses (Ivowi, 1990) in use in senior secondary schools in Nigeria have been designed in such a way as to:

- emphasise the fundamental unity of science;
- teach science as activities to which extent, students should *do* and not *read* science;
- realise that the order of accuracy is not as important as the illustration of principles (hence improvisation must be highly practised as an integral aspect of the students' activities;
- evaluate students in the three domains of educational objectives.

The work of STAN in curriculum development in Nigeria has been so pervasive that it has usually been regarded as a curriculum development agency. In the words of Ivowi (1993:353):

> In appraising the performances of the curriculum development agencies (in Nigeria), five such bodies, namely, the Nigerian Educational Research and Development Council, West African Examinations Council, National Teachers Institute, National Commission for Colleges of Education and the *Science Teachers Association of Nigeria have been singled out. STAN, a professional association that has contributed much to curriculum development in Nigeria is here regarded as a curriculum development agency.* It is a very typical and foremost example of such a professional association in Nigeria.

(b) Production of Textbooks

A number of STAS have been involved in the production of textbooks for use by pupils and teachers. The *Zambia Association for Science Education* (ZASE) has produced a series of *Teaching Notes* for the Junior Secondary School Leaving Examination in General Science. The handouts are published and distributed by the Curriculum Development Centre of the Ministry of Education.

These notes (Nwana, 1980) which have been written by classroom teachers have dealt with such topics as Water, Air, the Sun, the Universe, Life, Force and Energy. They are an invaluable supplement to existing texts in an effort to make science practical and relevant. The notes are moulded out of the Unit Plan idea

and each topic or content thereof has the intended teaching outcomes quite clearly spelt out for the guidance of the teacher.

The *Ghana Association of Science Teachers (GAST)* has also created a lot of impact on the production of textual materials GAST has published, Core Science Biology, Chemistry and Physics textbooks for Senior Secondary Schools. The books are produced in collaboration with Macmillan Education Ltd. and Unimax Publishers and are based on the syllabuses drawn up by the Ministry of Education. Each book follows a rational teaching plan covering the syllabus in the approved sequence.

However, by far, the greatest and most remarkable contribution in the area of textbook production by STAS in Africa is from the *Science Teachers Association of Nigeria (STAN).* Following the successful production of an Integrated Science Curriculum by STAN, a panel of authors was constituted to write Integrated Science textbooks for students and teachers. The major writing effort took place at the Conference Centre, University of Ibadan, in September 1970. According to STAN (1971b:iv) *'the seminars which preceded the actual writing should be properly recorded and studied as a successful model for achieving an integration of knowledge and methodology.'* It is worth noting that the STAN Integrated Science writing team combined the basic requirement for expertise, with broad geographical representation. A two-year course comprising Pupils' Textbooks, Pupils' Workbooks (for practical work) and Teachers' Guides was produced. First published in 1971, the books have since been revised and restructured into a three-year course comprising Pupils Textbooks, Pupils' Workbooks and Teachers' Guides. Between 1971 and 1993, several other titles have been published by the Association. Below is a full list of textbooks published by the Association:

Publisher:	Heinemann Educational Books (Nig) PLC
Titles:	Nigerian Integrated Science Project (New Edition) Pupils' Textbooks 1–3 Nigerian Integrated Science Project (New Edition) Pupils' Workbooks 1–3. Nigerian Integrated Science Project (New Edition) Teachers' Guides Chemistry for Senior Secondary Schools Biology for Senior Secondary Schools Physics for Senior Secondary Schools
Publishers:	University Press PLC
Titles:	Primary Science, Pupils' Books 1–6 Primary Science, Teachers' Guides 1–2 Primary Science, Work book 1
Publishers:	Longman Nigeria PLC
Titles:	Science Teachers' Handbook Agricultural Science for Junior Secondary Schools, Books 1–3

By August 1994, other titles are due for publication. These are the *STAN Mathematics for Junior Secondary Schools Book 1–3 with Teachers' Guides* to be published by University Press PLC and the *STAN Agricultural Science Textbook for Senior Secondary Schools* to be published by Longman Nigeria PLC. It is worth noting that some of the books written by STAN are used by some other countries.

An interesting dimension to textbook writing by STAS in Africa has been that some of the members of these STAS have through their experience in the activities of the Association, acquired competencies in book writing. In Nigeria, Prof. Sam Bajah, a fellow and Past President of STAN has been a renowned author. His book, *Teaching Integrated Science Creatively* (Bajah, 1983), has continued to serve as a useful companion for student teachers, teachers, science educators, administrators and researchers. This book is currently undergoing revision. In conjunction with Anthony Youdeowei, Prof. Bajah in 1982 published a series on Primary Science that has helped in no small measure in revolutionising science education in Nigeria.

The course (Bajah and Youdeowei, 1987) is presented in the form of six Pupils' Textbooks, one for each year of primary schooling. There are two accompanying Teachers' Guides. One Teachers' Guide covers Textbooks 1–3 while the other covers Textbooks 4–6. The series is also currently being revised to take care of the current requirement of the Primary Science Syllabus. Prof. Bajah is also currently being engaged in developing a pool of relevant *popular science series for 6–12 year-olds in Africa.* The project involves a package of video to accompany the series. Focused on the objectives of Project 2000+, the series should attract the attention of such agencies as UNESCO, the *African Forum for Children's Literacy in Science and Technology* and the *Commonwealth Foundation.* Like Prof. Bajah, many others have used their experience in writing individual texts. The current President of STAN, Prof. Uduogie Ivowi, is one of them. In his newly published book, Ivowi (1993:1) had this to say:

> My involvement with curriculum development in Nigeria started in 1968 when I was elected a member of STAN Curriculum Development Committee that produced the STAN syllabuses in Integrated Science and Physics. I also served on the STAN Committee that produced the Nigerian Integrated Science Project (NISP). Since then, I have played prominent roles in a number of other curriculum projects.

Such has been the impact of book writing by STAS in Africa. The *multiplier effect* has indeed been remarkable.

Elsewhere, Ivowi (1984) has elaborated on the *prospect from writing projects.* According to him, the sale of project materials (textbooks) could be very lucrative as STAN has, for example, been able to raise some revenue through royalties from books to organise conferences, seminars and courses, and sponsor its members to activities of similar professional bodies outside Nigeria. Even so, the Association has often found itself in very difficult financial situations as royalties from its titles are sometimes not sufficient for its pressing needs. This is so because the books are sold at considerably moderate prices to ensure 'grassroots' patronage

and to achieve the goals of the Association.

(c) Organisation of In-service Training for Teachers

The organisation of in-service training has been one of the major functions of STAS in Africa. This is usually done through conferences, workshops and seminars. These provide avenues for the exchange of information and interaction between designers and implementers of curriculum projects thereby leading to the professional growth of teachers and school administrators (Ivowi 1983). Virtually all STAS in Africa have been involved in teacher training. The Ghana Association of Science Teachers holds conferences each september. It also runs national and regional workshop in the various subject panels.

Similar workshops and conferences have also been conducted by the Zambia Association for Science Education (ZASE). In Nigeria, STAN has been holding annual conferences. Apart from the workshops organised by the 31 branches of the Association, 10 national workshops are conducted each year (Appendix H). Bajah (1993) reports that STAN conducts workshops for primary science teachers annually through its Primary Science Panel. According to him, over the period 1982–1992, STAN conducted eleven in-service workshops which involved an average of 136 primary science teachers in each workshop. Okebukola (1993) also reports that over 900 teachers benefit from the in service training offered by STAN. According to him, by the year 2000, STAN would have been involved in the retraining of over 40,000 science teachers since it was founded in 1957.

Besides, the Association served as a consultant in the *World Bank-Assisted Primary Education Project* in the training of Master trainers in Primary Science (STAN, 1992a.) This, obviously, was in recognition of the capability of STAN to offer high quality training for primary science teacher trainers. According to Otuka (1993), STAN spends a substantial percentage of its revenue annually on in-service teacher training. Similar commitments have been made by other virile STAS. Table 2, for instance, gives the budgetary provisions of a STA. In-service training (workshops, conference, science fairs) gets a substantial provision of twenty percent.

Even so, STAN'S role has often been misunderstood. Deeson (1993:6), for instance had this to say:

> Despite its name, STAN is not an association for school science teachers, but a professional institute. It seems to offer quite a lot to such people as teacher trainers (and even to pure scientists and engineers), but I am concerned that the practical needs of the people in the science classrooms and laboratories are addressed by nobody. School teaching (in all subjects) is extremely theoretical: chalk and talk; most teachers have inadequate knowledge of how to use even the few resources they have, and many, for sure, do not understand many basic science concepts.

Table 2
Percentages of provision in a national science teachers' association budget

Sub-Head	*Provision*
Transport & Travel	4%
Office & General	5%
Meetings	10%
Staff Emolument	15%
Publications	18%
Workshops, Conferences, Science Fairs	20%
Capital Development	28%
	100%

Nothing can be further than the truth. There are definitely problems yet unsolved, but STAN'S effort so far in STM teacher training and retraining within the limits of its lean resources is enormous, remarkable and worthy of emulation by other STAS.

(d) Organisation of Science Fairs

Science Fairs provide opportunities for individuals and groups to display the various science projects which they have undertaken. A project may set out to make discovery, develop new ways of demonstrating important principles or attempt to demonstrate practical applications of a known principle.

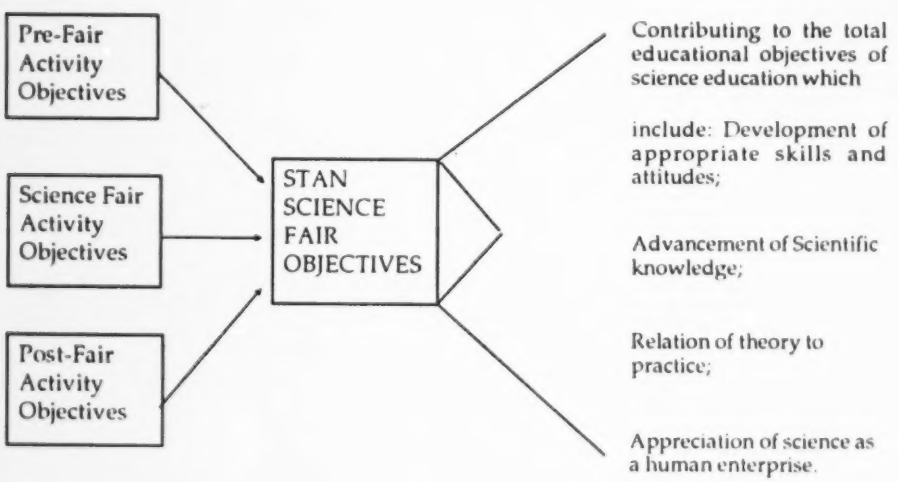
Pre-Fair Activity Objectives
Science Fair Activity Objectives
Post-Fair Activity Objectives
STAN SCIENCE FAIR OBJECTIVES
Contributing to the total educational objectives of science education which
include: Development of appropriate skills and attitudes;
Advancement of Scientific knowledge;
Relation of theory to practice;
Appreciation of science as a human enterprise.

Fig. 2 Objectives of STAN Science Fairs

Source: Obioha (1983:82)

Figure 2 gives a schematic representation of the STAN Science Fairs.

The Science Teachers Association of Nigeria and the Ghana Association of Science Teachers have in addition to organising Science Fairs in their respective countries (like other STAS in Africa) been engaged on discussions that will lead to joint Science Fairs in the near future. Some modalities have already been worked out and it is hoped that funds (which is the major impediment) will be available for this laudable scheme to take off very soon.

(e) Publication of Periodicals

STAS have also embarked upon the publication of periodicals such as Journals, bulletins (newsletters) and proceedings of conferences and workshops. These publications feature articles, research reports, innovations, science notes, reviews, approaches to science teaching, trends in science teaching worldwide and updates on members.

The Journal of the Science Teachers Association of Nigeria originally published twice a year, is now published once annually as two issues in one volume. The Journal is said to be the best in Africa and compares favourably with other reputable journals outside the continent (Otuka, 1993). The Journal caters for a wide range of disciplines; agricultural Science, Biology, Chemistry, Health Education, Home Economics, Integrated Science, Introductory Technology, Mathematics and other basic Sciences. STAN also publishes the *bulletin* twice a year as well as the proceedings of annual conferences and national workshops (see, for example, STAN, 1992). In addition, the various state branches of STAN have their bulletins.

Other STAS in Africa have floated their periodicals. The newsletter of the *Lesotho Science and Mathematics Teachers Association* comes out six times a year. The newsletter has a supplement for students that contains mathematics puzzles and games, a competition and suggestion for science activities. The February 1993 issue had ideas for activities with *water drops, growing spores* and *investigating balloons.* In 1992, The African Forum for Children's Literacy in Science and Technology provided a small grant for the Lesotho Science and Mathematics Teachers Association to publish its journal for a year.

(f) Research Work

STAS have been involved in a number of research projects in STM education. The Science Teachers Association of Nigeria (STAN) for instance has embarked on several research projects. Some of there efforts have led to the publication of the following position papers by the Association:

STAN Position Paper No. 1 *What is Science?*

STAN Position Paper No. 2: *Women in Science, Technology and Mathematics: The Nigerian Experience*

STAN Position Paper No. 3: *School Industry Link*

Two other research reports *History of STAN*, with Prof. Sam Bajah as writing Team Leader and *Humanism and the Science Curriculum* to be anchored by Emeritus Professor Emmanuel Yoloye, are underway.

Problems Encountered by Science Teachers Associations

Financial and Communication problems beset STAS

A number of factors have continued to militate against the performance of STAS. The two outstanding factors are of course, poor finance and lack of communication. In terms of finance, it would be said that, save for the NSTA and the ASE, STAS are virtually having financial difficulties though to varying degrees. Much of the revenue of each STA comes from dues from members. But because of fluctuations in membership strength, some STAS occasionally are unable to raise enough funds from this source to finance their programmes. According to Ikeobi (1993:2), 'nearly every STA in Africa is unable to survive, grow and flourish because the only regular source of fund — members' dues is subjected to entry and withdrawal of members from the Association.' Similarly, at the inauguration of FASE in Lagos, Nigeria, Nwana (1980:92) had this to say:

> The future for an association of science teachers and science educators in Africa should certainly be bright especially if one were to judge only by the enthusiasm with which the idea has been received ... But we must not overlook the fact that problems abound and there are many hurdles to clear ... We have much more to do in inaugurating this association than passing resolutions ... We need to give serious thought to the financing of the Association.

Those were the prophetic words of Professor O.C. Nwana, and today, FASE is virtually moribund, due largely to financial difficulties. The story has been the same for several STAS in Africa. Even those STAS that are moderately active, have been unable to set up permanent secretariats with the result that such STAS have been built around personalities, making perpetuity difficult if not impossible. The Zambia Association for Science Education (ZASE) is a good example. With the passing away of its General Secretary Mr. Thomas Varghese, the activities of the Association have been paralysed. ICASE has, in fact, reported a loss of contact with ZASE (see Appendix G). Even ICASE is not left out. Its Secretariat had to move recently from Hong Kong to Cyprus due to the movement of its Executive Secretary, Dr. Jack Holbrook. In Africa, the financial problem is further compounded by the non-sponsorship of the activities of STAS by industries and companies. This is contrary to what obtains in the U.K. and the U.S.A. where industries and companies sponsor several programmes of the ASE and the NSTA respectively.

The other major factor, *lack of communication*, which militates against the proper functioning of the STAS is partly a product of their poor financial position. Both Nwana (1980) and Ikeobi (1993) agree that poor communication has continued to threaten the activities of STAS as letters are often not replied to or received. And in the words of Holbrook (1993):

> The biggest problem that I face as Executive Secretary of ICASE is correspondence and obtaining information on concerns, developments and in general, on ways in which ICASE can play a role as an umbrella organisation. Currently I can cite the singapore science teacher association which has recently closed their P.O. Box. (I know because mail was returned). As yet I have not been able to re-establish contact.

The problem is not only between STAS. It also exists within STAS. The Science Teachers Association of Nigeria, for example, sends out from its Secretariat, a few thousand mails to its members annually but only receives a few hundreds in return. At the other extreme, however, some STAS in Africa do not correspond with members regularly.

Relationship of STAS with the machinery of government with respect to S&T policy formulation

STAS influence S&T policy through conferences, workshops; collaboration with government agencies, etc.

Science Teachers' Associations have been involved in S&T policy formulation by governments through the following ways:

(a) Floating of a policy document

According to Holbrook (1993), STAS such as the ASE in the U.K. are able to influence policy by creating their own policy statements and floating these so that the membership can interact and even vote. He maintains that among the membership of the ASE are influential governmental policy makers and hence the ASE dissemination process of floating policy statements and encouraging discussion in its publications influences science education thinking as documentation produced by the ASE is easily tabled during governmental policy meeting.

(b) Adoption of STA-initiated project by government

Sometimes a project embarked upon or initiated by a STA is adopted by government. In Swaziland, Slimming (1976) reports that the impetus for that country's Integrated Science project came when, in 1971, the *Swaziland Science Teachers Association (SSTA)* brought to the attention of the Ministry of Education's Science Teaching Panel their dissatisfaction with the existing Junior certificate syllabuses in Introductory Science and Biology. There was concern that the new course should encourage the study of science with an emphasis on individual experimentation and on understanding and constructive thinking; and it was strongly stressed that full account should be taken of the cultural and physical environment of the country. A set of proposals was put forward and the ministry of Education invited all science teachers to a meeting to consider these. After a lively debate the proposals were unanimously accepted and the swaziland Integrated Science Project (SWISP) thus came into being in March 1972. Similarly in Nigeria, the Nigerian Integrated Science Project (NISP) earlier reported on is the brainchild of STAN.

(c) Membership of Decision-Making Bodies

The Science Teachers Association of Nigeria has been able to influence S&T policy partly through its membership of the Joint Consultative Committee on Education (JCCE). The JCCE, inaugurated on 30 September, 1955 is Nigeria's highest advisory body on education to all governments of the Federation. It meets twice yearly and makes recommendations to the National Council on Education (NCE) for consideration and ratification. At each meeting of the JCCE, STAN presents a report on its activities. Occasionally, the Association in addition to the report, presents a memorandum on a particular subject. One of such memoranda in 1989, led to the establishment of special science secondary schools in Nigeria. More recently, on 9 December, 1993, STAN presented a memo to the JCCE plenary session calling on the Nigerian Federal Government to set up a *National task force on Project 2000*+. Membership of the JCCE has therefore enabled STAN to be aware of the direction of government policy well in advance and to influence it where possible. It is interesting to note that many members of the JCCE are Co-opted members of the Governing Council of STAN. These include: the Federal Ministry of Education, Nigerian Educational Research and Development Council, West African Examinations Council, National Teachers Institute, Joint Admissions and Matriculation Board, National Board for Technical Education, National Commission on Colleges of Education, National Board for Educational Measurement, and the National Business and Technical Examinations Board.

(d) Collaboration with Government Agencies

Active collaboration of STAS such as STAN with government agencies has led to new science education policies. The development of the *Nigerian Secondary Schools Science Project (NSSSP)* which produced textual materials in Biology, Chemistry and Physics was due to the collaborative effort of STAN and the then Comparative Education Study and Adaptation Centre of the University of Lagos. In fact, the writers of the series were guided considerably by the syllabus outlines earlier developed by the Science Teachers Association of Nigeria at the instance of the West African Examinations Council (WAEC). Other Nigerian government agencies such as the National Teachers Institute have also been collaborating with STAN either directly or by assigning some work to some of STAN's veteran members.

(e) Membership of Task forces, Commissions, etc.

STAS do influence government policy on S&T through membership of special tasks forces, commissions, conferences, etc. For instance, STAN in Nigeria participated actively during the nation's curriculum conference in 1992 in Kaduna. In fact, the STAN President, Professor Uduogie Ivowi served as the Rapporteur General. Similarly, the Association was represented at the workshop that led to the formulation of the Nigerian National Policy on Science and Technology.

(f) Holding Seminars, Workshops and Conferences

Holbrook (1993) has cited the holding of seminars, workshops and conferences as a means of influencing S&T policy. He believes that the involvement of governmental personnel as participants in these workshops can strongly influence policy and gives, as an example, the increase in the level of in-service provision for teachers in Hong Kong following the 4th ICASE-ASIAN symposium held in Hong Kong. Similar activities by GAST in Ghana, STAN in Nigeria and ZASE in Zambia have always received government attention and patronage. The Science Teachers Association of Nigeria usually publishes its conference communique and copies are made available to government. These communiques are highly regarded. Appendix I gives the 1993 conference communique of STAN.

How Science and Technology Policies Get to Teachers in the grassroots classrooms

STAS play a very important role in the transmission S&T Policy to Teachers

Figure 3 is a schematic diagram showing how national S&Tpolicies get to teachers in the grassroots classrooms. Once a policy on S&Thas been formulated, the relevant (Education) ministry collaborates with specialists — in Universities, other Higher Institutions as well as STAS — in producing the syllabus. In Some countries, the syllabus — appropriately called teaching syllabus — provides the performance objectives, teaching content, activities to be performed by the children as well as evaluation procedures. Nigerian syllabuses are typical examples. In others, the syllabuses serve examination purposes mainly. Textbooks are thereafter written by individuals, and groups. In some countries (such as Nigeria), STAS produce textual materials for both secondary and primary school teachers who make use of these in their interaction with students. The secondary and primary school science teachers along with lecturers in higher institutions and ministry officials constitute the membership of the Science Teachers' Association (STA). Where the STA is virile, its workshops, conferences and other teacher training programmes serve as veritable avenues for mutual exchange and updating of information on developments in STM education. There is therefore a lot for the system to lose wherever there is no STA or the STA is not active. In all, the scenario shows a lot of interactions with each unit lending support to the other in one form or the other. Even the students who are the last recipients of a S&T policy, must necessarily participate either directly or indirectly at each stage in the scheme since the focus is, without doubt, on them. Students' participation in science fairs in Ghana and Nigeria has for example, helped to improve the standards of fairs organised by STAN (GAST in Ghana and STAN in Nigeria) in these countries.

An aspect which can not be ignored is the central role which Science Teachers' Associations play in the propagation of S&T policy to the grassroots teachers. STAS play active part at all stages as aptly illustrated by the following two Case Studies from Nigeria.

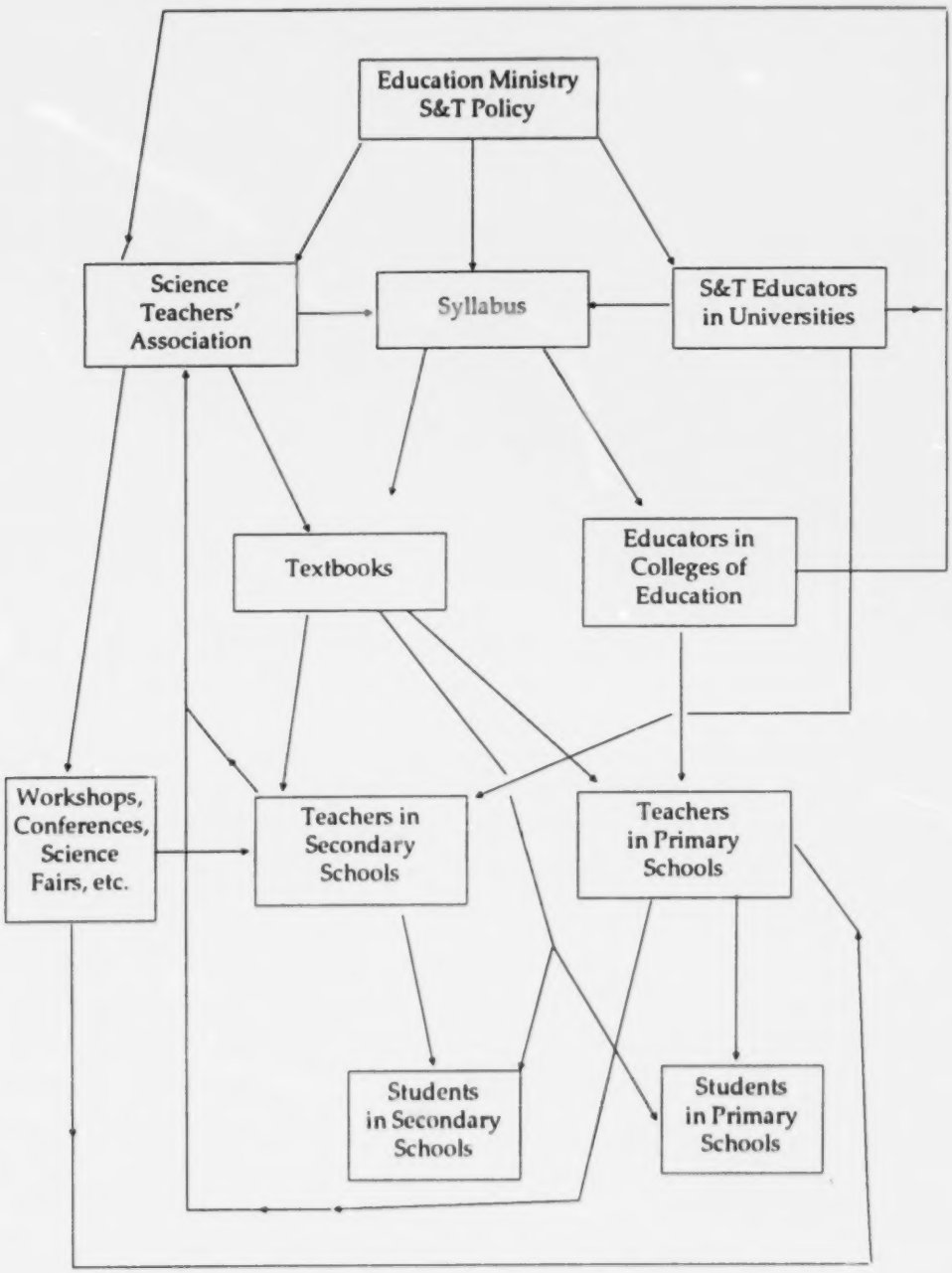

Figure 3: Schematic diagram showing how national S&T policies get to teachers

Case Study 1

An example of the introduction of a new S&T policy in Nigeria was the change from the 6-5-2-3 system of education to the 6-3-3-4. Here the Science Teachers Association of Nigeria participated in conferences leading to the change of policy, was instrumental to the production of syllabuses in science subjects and, in fact, went ahead to produce some textual materials. The Association also organised workshops, conferences and seminars on the new system for its members. Some of those conferences drew membership from Ministry of Education officials, science teacher educators, publishers, and students. *Thus through the effort of STAN, teachers were aware of the demands and modalities for the implementation of the new system of education well in advance.*

Case Study 2

Another case study showing the role of STAN in the transmission of policy on S&T was the formulation of the *Nigerian National Policy on Science and Technology* (Federal Republic of Nigeria, 1986). STAN actively participated (and collaborated with the Nigeria Academy of Science) in the process of formulating the policy. It is little wonder then that some aspects of the policy emphasise the need for sound basic education in science. The policy, for instance, states that "in the teaching of science, local examples should be used particularly at the early stage of introduction to science" (Federal Republic of Nigeria, 1986:7). The participation of STAN in the formulation of the policy, therefore, not only enabled it to influence the policy but also to explain the implications of the policy to its members during workshops and conferences so that each member was aware of the nature of the policy and was ready to implement it.

National Science and Technology Policies and Felt needs of the African Community

African countries possess laudable S&T policy documents which focus on *relevance*. But implementation problems have occasionally dwarfed these ideals leading to loss of opportunities. Still, the African remains resilient, looking into the future with renewed hope.

Science and Technology (S&T) are crucial factors of economic and social development of any country. The adoption of a sound S&T policy in national life makes the difference between a developed and a developing country. The developed countries such as the U.S.A. and Japan have made tremendous use of S&T. They now dominate the world markets. On the other hand, the developing countries such as Nigeria and virtually all African countries (except, perhaps, South Africa) have been barely managing to survive. African countries lack sound S&T infrastructure with attendant abject poverty, huge debt, low literacy, etc. In consequence, each African country has formulated its own policy on S&T to cater for the *felt needs* of its citizens. There has therefore been, of recent, a conscious effort to seek for *relevance* of S&T policies vis-a-vis the contemporary problems in Africa. In Nigeria, the National Policy in Science and Technology (Federal Republic Nigeria, 1986:7) states, inter alia:

> Science must ... be domesticated for it to be effective and its teaching in the institutions of learning, made purposeful and *relevant* to the country's cultural milieu. Accordingly, in the teaching of science, local examples should be used particularly at the early stage of introduction to science.

In order to ensure that the S&T policy is relevant, the Nigerian government seeks to:

- make it possible for the average child to have early contacts with the concepts of, and materials related to, S&T even before attaining primary school age.
- ensure a sound science foundation during the first six years of the 6-3-3-4 educational structure.
- enforce strictly an absolute minimum of 60:40 ratio of science — based to other disciplines in student yearly enrolment into the nation's universities with the target ratio of 70:30.

- work towards establishing at least one Trade Centre/Vocational School in each Local Government Area of the country.
- ensure that adult education includes, in addition to learning how to read and write, learning how things around us work.

Similarly, the *Nigerian National Policy on Education* clearly states that secondary education (for instance) should serve as a preparation for *useful living* within society and for *higher education.* According to Ivowi (1990), these two factors are satisfied at the senior secondary school by the provision of *vocational* and *academic education.* He contends that the science and mathematics curriculum contents are comprehensive, relevant and widely appealing in scope, depth and application.

In Botswana, Nganunu (1992:120) reports that in developing the science syllabus, the approach used was:

- to identify the needs of the society through consultation with various departments and organisations; areas of national interest and concern included issues like water conservation, diarrhea and death from dehydration, car accidents, mining and pollution; these areas had to be covered in the syllabus; and
- to identify the needs of the individual by identifying the activities people do in their daily lives (e.g. describing the activities done by a school-boy in town, a woman in the rural areas, a city worker, and a mother); then identify what science is needed to do these activities; from there, syllabus activities were framed and finally the objectives sorted into topical themes such as *Water for Living, House Construction, and Keeping Healthy.*

According to Nganunu, the outcome was a syllabus that contained topics and skills not found in the traditional academic science curriculum such as *building solar devices* (Botswana has 320 cloudless days per year), *preparing an oral rehydration therapy* (because diarrhea is a major killer of children).

Ghana is another country that is seeking the *relevance* of its S&T policy through the *science in Ghanaian Society Project.* Funded by the British Council and UNESCO, the project has the following objectives (Yakubu, 1992:14):

- To study local industries in order to identify the scientific concepts and processes embedded in them .
- To produce books on local industries and other aspects of Ghanaian culture relevant to science teaching.
- To develop industry-oriented or interdisciplinary methods of science teaching.
- To investigate ways of improving the image of the world of work of Ghanaian youth, especially senior secondary, junior secondary and technical school leavers.

In the same vain, Ajeyalemi (1990) surveyed science and technology offerings in Ghana, Nigeria, Uganda, Zambia, Zimbabwe, Lesotho and Swaziland and

noted that all the science curricula recently developed in these countries placed less emphasis on the purely academic curriculum and more on *relevant* and functional education. For example, Zimbabwe has an issues-oriented curriculum dealing with the following themes:

- Science in Agriculture
- Science in Energy use
- Science in Structures and Mechanical systems
- Science in Industry
- Science in Community.

Bajah (1982) has equally advised that a science programme which strives for *relevance* in Africa must take into consideration most of the points relating to *need, usefulness, modernity* and *acceptability*. Elsewhere, Bajah (1988) contends that many African countries have evolved their own educational systems in which education at all levels focuses on *relevance*.

However, it does appear that in spite of the good intentions of the various national S&T policies in Africa, namely, that of seeking relevance, the situation on ground can hardly justify this claim. In the words of Ajeyalemi (1992:117):

> Whether in Zimbabwe or in any of the other countries (eight African countries were studied) ... the classroom implementation is contrary to expectations of the science curriculum developers. Science instruction is teacher-directed, theoretical and textbook-bound ... Nor has science education in these African countries succeeded in meeting the needs of the very few college and university bound students with science career aspirations. It has certainly not been appropriate for the larger majority who need science for meeting personal needs, for resolving societal problems, or for developing career awareness ...

Ajeyalemi lists poor economic conditions of most African countries, centralisation of the educational system, limited public awareness of, and possibly support for, science and poor quality of teachers as some of the reasons for the discrepancy. Similarly, Ogunniyi (1984) has stated that science teaching in Africa is being hampered by inadequate teaching facilities, lack of funds to purchase equipment, poor readability of textbooks, large classes, lack of well-trained science teachers, poor motivation of teachers and the negative influence of external examinations. It is with this avalanche of problems that Ogunniyi feels that *education for rural transformation* is not only hypocritical but unattainable in the present circumstances. In his words (Ogunniyi, 1984:23):

> Those advocating for *rural transformation* by means of appropriate science education programmes are neither living in rural areas nor are they contemplating that they themselves nor any member of their family would do so now or in the future ... The lack of virtually all the basic amenities of life ... the conspicuous absence of youthful energies among the farming communities and so on make education, and science

education in particular, orientated towards rural life, to say the least, a hollow and a bogus propaganda.

What all this means is that there is a discrepancy between S&T policy and practice in Africa. If S&T education must be truly *relevant*, governments in the various countries in the continent must as a matter of deliberate policy ensure that relevant education, particularly S&T education, is not only on paper but actually put into practice. It is only in this way that the continent can hope to benefit from the tenets of Project 2000+.

- **COMSEC, UNESCO, others should support virile STAS and resuscitate ailing ones.**
- **Governments should give priority attention to adequate funding of S&T education.**
- **A Foundation should be established for ICASE.**
- **NSTA, ASE should assist other STAS.**
- **STAS, schools, parents, industries, others should work in concert.**

The discussion so far inevitably leads to recommendations for the implementation of S&T education for all. Of paramount importance is the fact that the provision of *S&T education for all, in all countries* requires concerted efforts of several agencies, governments, the public and individuals. Accordingly, the approach adopted here is to highlight some of the roles in which the following agencies/groups are expected to play in our bid to provide S&T education for all:

- International Agencies — Commonwealth secretariat, UNESCO, etc.
- Governments.
- International Council of Associations for Science Education (ICASE).
- National Governments.
- Science Teachers Associations (STAS).
- Schools.
- Industries.
- Parents.

Role of International Agencies

As earlier highlighted, STAS have a major role to play in the implementation of S&T for all. However, in many African countries, their impact is either very low or non-existent. International agencies such as the *commonwealth secretariat* and *UNESCO* are hereby called upon to assist in resuscitating all ailing STAS and also to further strength those that are currently virile before they too become

moribund. For a start, the Commonwealth Secretariat is called upon to assist in the following areas in the developing countries of the Commonwealth:

- Where STAS are ailing, support should be provided for their resuscitation.
- STAS should be encouraged to set up permanent paid secretariats to enhance their effectiveness. GAST in Ghana, for example, is long overdue for a permanent secretariat. A delay can only lead to further deterioration in the scope of its activities. The Commonwealth Secretariat should provide technical expertise preferably from within Africa. The STAN secretariat in Nigeria could be helpful in this direction. Similar efforts should be made in countries like Botswana, Zambia and Zimbabwe.
- Financial support should be provided for projects embarked upon by STAS especially in furtherance of Phase III of Project 2000+.

Role of Governments

Governments are expected to do the following:

- Support for STAS — These are in the area of funding, representation on governing bodies of STAS, patronage of programmes such as workshops, conferences and seminars. Award of contracts to STAS to strengthen their revenue base — such contacts are usually cheaper for governments and better executed since STAS have the human resources.
- *In-service training for teachers:* This should be done in close association with STAS to avoid duplication of efforts. In addition Educational Institutes should be encouraged to embark upon distance education.
- *Books and Library Development:* Governments should as a matter of urgency procure S&T books for schools and libraries. Support should also be given to STAS to publish S&T textbooks.
- *Personnel Management:* This involves provision of adequate data and effective (even) distribution of teachers. In Nigeria, for instance, S&T teachers, are in short supply in rural schools.
- *Admission Policy;* Entrants into the S&T teaching profession should be those with reasonably good qualifications. Mediocres should be discouraged.
- *Conditions of Service of Teachers:* S&T teachers like other workers require a high morale to operate effectively. Policies and positive actions in this direction are needed.
- *Public Awareness:* By and large, the public has a role to play in S&T education. Government should help to create this awareness via deliberate campaigns in hand bills, posters, radio/television programmes and newspaper articles.

- *Fund Allocation:* This is where the problem lies. Most governments will give on paper very lofty objectives in S&T. However, the release of budgetary allocations very often proves difficult. On the contrary, African governments easily and willingly sponsor sporting and other activities that tend to boost their political egos. STAN (1992b) feels that this implies paying *'lip-service'* to S&T education.

Role of ICASE

As one of the initiating agencies of project 2000+, the central role of ICASE towards the success of the scheme cannot be underestimated. ICASE is expected to play a co-ordinating and supervising role. But more importantly, *ICASE should support STAS financially.* Unfortunately, ICASE doesn't have funds of its own. This brings to the fore the need to establish a *foundation* to support the activities of ICASE. Until this is done, much of the lofty ideas of that organisation will remain unfulfilled and all nations will be worse of for the inaction. It is hoped that this will receive a favourable attention of the governing body of ICASE. This will inevitably lead to the establishment of a permanent secretariat for ICASE which is highly desirable.

Role of Science Teachers' Associations

To enhance the attainment of S&T literacy for all, STAS are expected to:

- strengthen themselves through more membership drive, functional structure, establishments of permanent secretariats and revenue generation. Revenues could be sourced through commercialised book-development efforts and the provision of consultancy services to governments, industries, etc.
- execute S&T programmes such as S&T fairs, camps, workshops, lectures, seminars, symposia, films, conferences, newsletters (bulletins), journals, science prizes, badges and road shows. STAS could also sponsor S&T radio and television programmes as well as the activities of S&T clubs in schools.
- embark upon international co-operation with other STAS. More privileged STAS such as the NSTA and the ASE should consider offering support to the less privileged. Both organisations (NSTA & ASE) have, for instance, been co-operating with STAN in the areas of training, conference participation and exchange of publications. Fortunately, the International committee of the NSTA recently voted to provide more support in this direction to STAS in all countries.

According to NSTA (1993 a), the Association is determined to:

- promote formal partnerships and exchanges with other science teachers and among science teacher associations worldwide.

- promote international conferences, seminars, and sessions fostering global awareness of issues, ideas and trends in science education.
- promote multicultural science education.
- encourage global transfer of information related to science teaching and learning.

Similarly, the ASE's teacher scholarship scheme is a worthy and commendable effort and there is the desirability that the scheme, which aims to promote the exchange of curriculum development ideas in the teaching of science between the U.K. and Australia, be extended to cover other regions, particularly Africa. The Commonwealth Secretariat should assist in this respect by liaising between the ASE and STAS.

Role of Schools

Schools are expected to encourage their teachers to participate in the activities of STAS by authorising their release and sponsorship. Schools should also provide the enabling atmosphere for S&T teaching as well as conduct career counselling service for students.

Role of Industries

Industries are called upon to sponsor S&T programmes. In Nigeria, an education tax has been introduced. The policy aims at compelling industries to pay 2% of their earnings as education tax. This is a commendable effort. What remains is to see how government will channel such income to education, particularly S&T education. By and large, other countries are advised to follow suit.

Parents

Parents are implored to provide S&T toys to their children, embark on home teaching and visit S&T centres. These reinforce the activities that take place at school. Parents should also encourage the children to use S&T badges and join S&T clubs such as the Junior Engineers Technicians and Scientists Clubs in Zambia and Nigeria. Incidentally, the United Nations has declared 1994 as the *International Year of the Family*. It is therefore hoped that every family in every nation will work towards the enhancement of S&T education for *all*, in *all* countries in 1994 and beyond.

Conclusion

The experience of virile STAS are vital for all

This study has revealed the enormous impact which Science Teachers' Associations (STAS) have created on Science and Technology education in countries where they are virile. This has been the case of NSTA in the U.S.A., the ASE in the U.K. and STAN in Nigeria. STAS' influence has been experienced in the area of curriculum development, production of textual materials, organisation of training programmes and formulation of S&T policy. STAN, in Nigeria, has exerted so much influence in S&T education that it is difficult to imagine what would have happened without it.

Unfortunately in Africa, virile STAS are few. But this should not be the case because as the world awaits the implementation of the Phase III of Project 2000+, it can ill afford to ignore the positive role of STAS. The experience of STAN is a pointer to the enormous gap that must be existing in an African country with an ailing STA. This is why positive action is needed in continuing support for virile STAS and the resuscitation of ailing ones. Both the Commonwealth Secretariat and UNESCO should consider taking urgent and decisive action in this direction.

In the same vein, there is the need to establish a Foundation for ICASE as well as encourage closer partnerships among STAS in the various regions. The NSTA and ASE are implored to collaborate and co-operate more actively with STAS in Africa.

Finally, governments, IGOs, NGOs and other agencies of education must work in concert within the framework of Project 2000+. It is only in this way that we can ensure, as Goldsmith (1991:17) has stated "that the illiterate, numbered in millions, are provided with means of learning to become an unchallengable and vital national resource." This is, essentially, the basis of *S&T education for all.*

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Appendix A

Project 2000+: International Forum on Scientific and Technological Literacy for All

Declaration

At the conclusion of the International Forum on Scientific and Technological Literacy for All held at UNESCO Headquarters, Paris 5–10 July 1993, about 400 participants from more than 90 countries endorsed the following declaration.

We, participants in the Project 2000+ Forum meeting at UNESCO, Paris, France from 5–10 July 1993:

1. *Recalling* the World Declaration on Education for All, in particular its recognition that sound basic education is fundamental to the strengthening of higher levels of education and of scientific and technological literacy and capacity and thus to self-reliant development and further recalling recent worldwide expressions of concern for the environment and for quality of human life especially those contained in Agenda 21, the output of the United Nations Conference on Environment and Development, Rio de Janeiro 3–14 June 1992.

2. *Believing* that scientific literacy and technological literacy are essential for achieving responsible and sustainable development.

3. *Declare* our full commitment to the promotion of science and technology education for all in keeping with the world Declaration on Education for All, and our readiness to contribute through Project 2000+ to the concerted action set out in the Framework for Action to Meet Basic Learning Needs.

4. *Call* on government, industry, public and private sector interests, and education and other authorities in all countries to:

(a) review critical existing provisions for science and technology education at all levels and in all settings with the aim of giving appropriate attention do development and maintenance of learning programs responsive to the needs of individuals and communities;

(b) assign such steps as may be necessary to ensure equity of access for everybody to science and technology education, notably for all with the aim of achieving responsible and sustainable development;

(c) take such steps as may be necessary to ensure equity of access for everybody to science and technology education, notably for women and girls, young children and other under-represented groups.

(d) develop appropriate in-school and out-of-school opportunities, programmes, curricular and assessment procedures for science and technology education responding to the human needs of a scientific and technological society;

(e) ensure and support appropriate pre-service and continuing in-service provisions for those responsible for all forms of science and technology education;

(f) encourage and support evaluation, research and development in science and technology education in both formal and non-formal sectors;

and to this end:

(g) establish and support task forces involving partnership with public and private education bodies and councils; these might include universities and other institutions of higher and further education, research institutions, libraries, interactive science centres, environmental areas, nature reserves as well as public and private bodies active in the fields of agriculture, natural resources, environment, health, industry, commerce and the media, and also organisations and individuals specially concerned with science and technology education.

(h) recognise the central role of teachers in achieving scientific literacy and technological literacy for everybody and enhance the status of careers in science and technology education at all levels;

(i) recognise the capital role of institutions of non-formal education, such as museums and scientific centres, of the media (radio, television and the press) and of all other out-of-school channels for communicating knowledge of science and technology, in fostering scientific and technology literacy for all; and develop activities designed to set science and its applications in a wider social and cultural environment:

(j) ensure that adequate resources are available to achieve these aims;

5. *Urge* United Nations Agencies and other inter-governmental organisations to work together to initiate and support programs which will advance the ability of countries and of populations to shape their own future in a scientific and technological society and which will increase the capacity of countries for designing, planning and implementing scientific literacy and technological literacy programs.

6. *Urge* non-government organisations active in fields of science and technology education, as well as the social science, and professional associations of teachers and educators and educational organisations at all levels to:

enter into partnership with, and make their knowledge and experience available to, United Nations and other inter-governmental bodies as well as establish innovative programs in a common effort to achieve the goal of scientific literacy and technological literacy for all; and

participate in national, regional and international programs for the enhancement of scientific and technological literacy for the improvement of the quality of life in all societies and for the achievement of sustainable development.

7. *Recommend* that UNESCO make provision, within its Medium Term Plan (1996–2001) in the field of education, and in the context of Project 2000+, for an international program to develop co-operation among all countries in the field of science and technology education, with particular reference to the promotion of scientific literacy and technological literacy for all.

This program, conducted in partnership with the relevant and competent government and non-governmental organisations and agencies, should focus on regional and sub-regional co-operation and on strengthening networks for exchange of ideas, information, human and material resources for science and technology education, and actively seek to promote world-wide:

(a) understanding of the nature of and the need for, scientific literacy and technological literacy in relation to local culture and values and to the social and economic needs and aspirations of each country and its peoples, and also in accord both with the general aims of education for the all-round development of human personality and with human rights and basic freedoms;

(b) identification of those issues concerning the applications of science and technology which are of special importance for personal, local and national development and their embodiment in educational programmes;

(c) establishment of teaching and learning environments as well as supporting structures conducive to the achievement of scientific literacy and technological literacy for all;

(d) formulation of guidelines for the preparation and continuous professional development of science and technology educators and leadership coupled with assistance to countries in giving effect to them;

(e) development of effective communication both verbal and visual, assessment strategies and evaluation programs designed to enhance general levels of scientific literacy and technological literacy;

(f) support for the non-formal and information sector in its own right and support for development strategies which will help to stimulate and maintain lifelong scientific literacy and technological literacy.

8 *Recommend* that by the year 2001 there be in place appropriate structures and activities to foster scientific literacy and technological literacy for all, in all countries.

Appendix B

African Primary Science Programmes (APSP)

Selected Titles

1. How the sky looks.
2. Stars over Africa.
3. Strangers in the sky.
4. Using the sky.
5. Common stubstances around the Home (mixing powders and liquids).
6. Measuring Time.
   Part II: Making clocks that measure hours
7. Colours, Water and Paper.
8. Construction with glass.
9. Activities for lower Primary: Water.
10. Chima makes a clock.
11. Activities for lower primary: Cooking.
12. Estimating Numbers.
13. Ourselves: Activities and Experiments.
14. Seeds.
15. Sinking and Floating.
16. Small Animals.
17. Tilapia.
18. Chicks in the classroom.
19. Ask the Ant Lion.
20. Activities for Lower Primary: Dry sand.

Appendix C

Science Education Programme for Africa Handbook for Teachers of Science

Contents

SECTION 1: INTRODUCTION
CHAPTER I The Philosophy of the Activity Approach to Primary Science Education
CHAPTER II How the Handbook may be used

SECTION 2: ILLUSTRATIONS OF STUDENTS DOING SCIENCE
INTRODUCTION
CHAPTER I Investigations With the Ant Lion
CHAPTER II Solar Eclipse
CHAPTER III A Draft of a Teaching Unit
CHAPTER IV Stretching of a Rubber Band
SUMMARY

SECTION 3: SCIENCE ACTIVITIES AND RELATED READINGS
INTRODUCTION
CHAPTER I Liquids
CHAPTER II Strength of Materials
CHAPTER III Changing Systems
CHAPTER IV Motion
CHAPTER V Relations and Functions
SUMMARY

SECTION 4: ILLUSTRATIONS OF CHILDREN DOING SCIENCE
INTRODUCTION
CHAPTER I The Sensitive Plant
CHAPTER II Unawajua? (Do You Know Them?)
SUMMARY

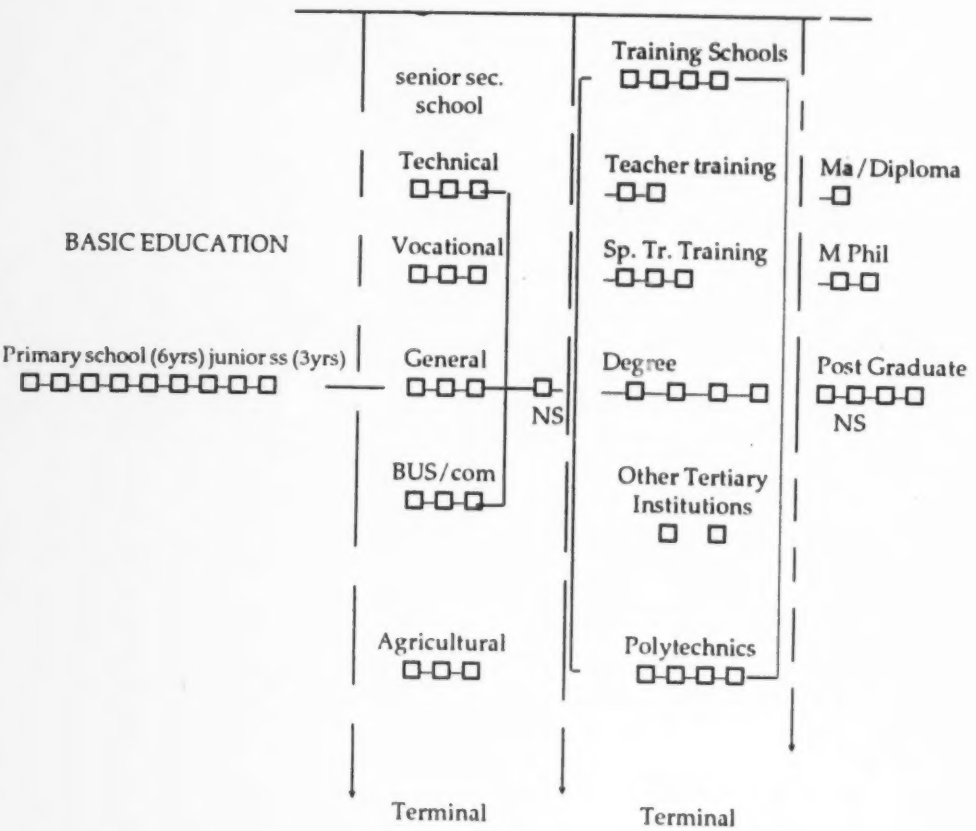
SECTION 5: RELATING WITH CHILDREN
INTRODUCTION
CHAPTER I Teaching Science by Recognizing Individual Differences
CHAPTER II Intellectual Development
CHAPTER III How Children View the External World
CHAPTER IV Motivating Children to Learn
CHAPTER V The Role of Culture in the Learning of Science
SUMMARY

SECTION 6: GETTING READY FOR THE CLASS
INTRODUCTION
CHAPTER I Strategy for Unit Construction
CHAPTER II Assessing Children's Experiences
CHAPTER III Questioning Techniques and Skills
CHAPTER IV Keeping Records
SUMMARY

BIBLIOGRAPHY

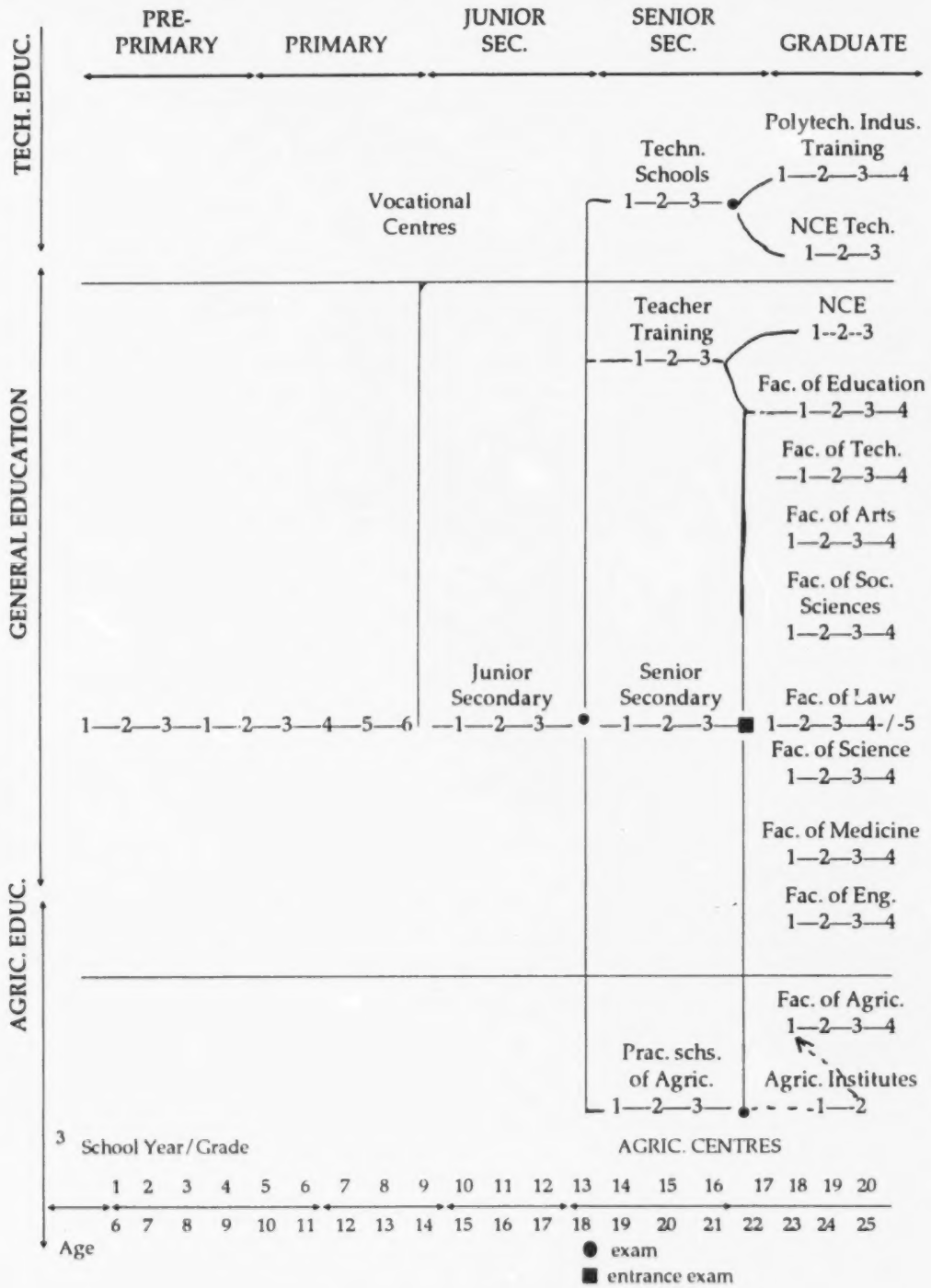
Appendix D

New Structure of Education in Ghana



Appendix E

Nigerian Education System (6-3-3-4)



Appendix F

Nigerian Core Curriculum for Primary Science: Contents

YEAR ONE

1. Exploring the environment (a) A nature discovery walk around the school compound.
2. Using the Senses: Sight, hearing, touch, taste and smell.
3. Simple Properties of Air: Existence of Air
   Air occupies space.
4. Water:
   - Sources of water
   - Its uses at home
   - Sinking and flating of objects
   - Water play.
5. Common Foods
6. Health and Safety
7. Housing and Clothing
8. Modelling

YEAR TWO

1. Observing animals from the local environment.
2. Grouping by shape, size and colour (for example, leaves, buttons, etc.) making leaf print.
3. Ordering of objects by comparing volumes, weights and lenghts.
4. Growing plants from seeds.
5. Air and Wind: Moving air from one container to another.
6. Further activities with water.
7. Health and and Safety: Care of the body.
8. Housing and Clothing.
9. Making figures and models of simple objects using match box and clay and making leaf print.

YEAR THREE

1. Further activities on plants and animals — comparison of major characteristics.
2. Further activities on Air and Water.
3. Force as push and pull.

4. Measurement: Length, Time and Mass: Comparing Volume.
5. Simple activities with mirrors and images.
6. Making sound with different local materials.
7. Colour: Dyes from plants and soil.
8. Technology: Local examples of things and practices we try to do to make work easier or more identification of simple machines and tools.

YEAR FOUR

1. Soil: Types and Constituents.
2. Gardening — Growing better plants, Growth and Food (practical, observation and measurement).
3. Food Types and Uses — Food gives us energy which we need to grow and work.
4. Simple ideas on heat and temperature.
5. Water Cycle — Evaporation and Condensation: Things which dissolve and things which don't. Filtering and Purification.
6. Weather — Regular observation and recording
7. Further activities on measurement of length in metre, centimetre, and volume in litre.
8. Names of colours, different shades of the same colour, making rainbow, observing natural colour and changes.
9. Exploring the human body — Bones, Joints, Muscles and Movement.
10. Health and Safety: Simple first Aid.
    - — How to clean wounds, stop bleeding.
    - — Treatment of stings, bite (dog, snake, scorpion, wasp bites).
11. Technology: Identification of materials:
    - — Metalic, Wood, Rubber, Plastic, Glass and Ceramic.

YEAR FIVE

1.
    - — Pressure
    - — Propulsion, Glider, Flight of Birds and Kites
    - — Burning.
2. Domestic Farm Animals: Visit to farms, Raising and Maintenance of Chicken Poultry.
3. Electric Circuit:
    - — Ways of Lighting Bulb
    - — Conductor and Insulator (non-Conductor)
    - — Uses of Electricity in everyday life.
4. Heat, Energy and Temperature.
5. Rocks: Classification: Constituents: Uses of Rocks.
6. Soap and Alkali.

7. My Body at Work:

   Breathing System
   Feeding System
   Excretory System.

8. How life begins in:
   (a) Plants
   (b) Animals.
9. Health and Safety: Common diseases.

YEAR SIX

1. Simple machines, types and uses.
2. Improving crop yield (project essential).
3. Simple ideas about magnets.
4. Minerals: Types and Uses.
5. Our Earth and Sky.
6. More about the Environment.

Appendix G

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Appendix H

SCIENCE TEACHERS ASSOCIATION OF NIGERIA
P.M.B. 5075, IBADAN
SCHEDULE OF NATIONAL WORKSHOPS FOR 1994

PANEL	THEME OF WORKSHOP	DATE
1. AGRICULTURAL SCIENCE	Practical Approach to the teaching of crop and animal production in Agriculture.	21 – 26 March, 1994
VENUE: Wesley College, Ibadan, Oyo State		
Contact Persons:		
Chairman: Mr. J.O. Otegbade, Oyo State School of Science, Idere, Ifeloju Local Government, Igboora, Oyo State		

PANEL	THEME OF WORKSHOP	DATE
2. BIOLOGY	Practical Approach to the teaching of nutrition and respiration	11–16 April, 1994
VENUE: Osogbo Grammar School, Osogbo, Osun State		
Contact Persons:		
Chairman: Mr. N.G. Ladon College of Education, P.M.B. 01000, Gindiri, Plateau State		
Secretary: Mr. P.O.Okorie, MSTAN Umuachama Amamba, P.O. Box 219, Uzuakoli, Abia State		

PANEL	THEME OF WORKSHOP	DATE
3. CHEMISTRY	Basic laboratory skills for effective teaching of Chemistry	18–23 April 1994
VENUE: Government College, Katsina, Katsina State		
Contact Persons:		
Chairman: Miss P.M. Ibole, MSTAN Science Unit, Secondary Education Management Board Headquarters, P.M.B. 1281, Owerri, Imo State.		
Secretary: Mr. A.A. Mohammed Government Science Secondary School, Kofin Madaki, P.M.B. 0184, Bauchi, Bauchi State.		

PANEL	THEME OF WORKSHOP	DATE
4. INTEGRATED SCIENCE	Teaching controling components of the enviroment in the Integrated science Curriculum	25–30 April, 1994
VENUE: Holy Rosary Girls' Secondary School, Port Harcourt, River State		
Contact Persons:		
Chairman: Mr. M.S.A. Tureta, MSTAN Inspectorate Department, Ministry of Education Headquarters, Sokoto, Sokoto State. *Secretary:* Mr. J.F. Chundusu College of Education, P.M.B. 01000, Gindiri, plateau State		

PANEL	THEME OF WORKSHOP	DATE
5. MATHEMATICS	Teaching quadratic functions and sets/logic in further mathematics.	2–7 May, 1994
VENUE: Hope Waddel Training Institute, Calabar, Cross River State		
Contact Persons:		
Chairman: Prof G.O. Obioma, MSTAN Faculty of Education, University of Jos, Jos, Plateau State.. *Secretary:* Alhaji Bashir Wada Kisauri Ministry of Education Headquarters, P.M.B. 2023, Katsina, Katsina State.		

PANEL	THEME OF WORKSHOP	DATE
6. PHYSICS	Practical Approach to the teaching of work and energy.	9–14 May, 1994
VENUE: Federal Government Girl's' Colege, Bauchi, Bauchi State		
Contact Persons:		
Chairman: Mr. E.A. Eze Department of Science Education, Enugu State University of Technology, P.M.B. 1660, Enugu, Enugu State. *Secretary:* Mr. O.A. Salau Comprehensive High School, P.M.B. 001, Ayetoro, Ogun State.		

PANEL	THEME OF WORKSHOP	DATE
7. PRIMARY SCIENCE	Practical Approach to the teaching of Electricity and Water in Primary Science.	23–28 May, 1994
VENUE: Kwara State College of Education, Ilorin		
Contact Persons:		
Chairman: Mr. B.A. Gankon, MSTAN Kaduna State College of Education, Kafanchan, Kaduna State.		
Secretary: Mrs. M. E. Otu-Bassey, MSTAN P.O.Box 1506, Shomolu, Lagos State		

PANEL	THEME OF WORKSHOP	DATE
8. SCIENCE, TECHNOLOGY & SOCIETY	The Impact of Desertification and Erosion on Society.	30 May – 4 June, 1994
VENUE: Enugu State University of Technology, Enugu, Enugu State		
Contact Persons:		
Chairman: Chief (Dr.) Engr. E.C. Ukaha, MSTAN The Presidency, National Assembly Office, Block 440, Zone 1, Wuse, P.M.B. 141, Abuja.		
Secretary: Mr. A.B. Cirfat, MSTAN College of Education, P.M.B. 01000, Gindiri, Plateau State.		

PANEL	THEME OF WORKSHOP	DATE
9. TEACHER EDUCATION	Discovery and enquiry approaches in teaching Science, Technology and Mathematics.	6– 11 June, 1994
VENUE: Education Resource Centre, Jos, Pleteau State		
Contact Persons:		
Chairman: Dr. E.U.U. Akpan, MSTAN Department of Curriculum Studies, University of Jos, Jos, Plateeau State.		
Secretary: Mr. S.O.C. Okeke Department of Science Education, Nnamdi Azikiwe University, Awka, Anambra State.		

PANEL	THEME OF WORKSHOP	DATE
10. TECHNOLOGY EDUCATION	Strategies for effective teaching of design and fabrication in Introductory Technology	12–18 June 1994
VENUE: Government Technical College, Awka, Anambra State		
Contact Persons:		
Chairman: Mr. Chike N. C. Okpala, MSTAN Government Technical College, Awka, Anambra State. *Secretary:* Mr. L.A. Nwugo Secondary Education Management Board Headquarters, P.M.B. 1281, Owerri, Imo State.		

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Appendix I

Communique For The 34th Annual Conference of the Science Teachers' Association of Nigeria

1.0 The 34th Annual Conference of the Science Teachers Association of Nigeria (STAN), was held at Government College, Katsina, Katsina State from 16–21 August, 1993. Teachers of Science, Technology and Mathematics from 27 States of the Federation and the Federal Capital Territory, Abuja attended the conference. A delegate from the Association for Science Education (ASE), Mr Eric Deeson and the Director of the British Council Assisted Nigerian Integrated Science Teacher Education Project (NISTEP), Mr Paul Turton, based in Zaria, Kaduna State, actively participated in the conference.

2.0 The theme of the conference was "Professional Development and Retention of Personnel for Effective Science, Technology and Mathematics Education in Nigeria."

3.0 The conference was declared open by the Executive Governor of Katsina State, His Excellency, Alhaji Saidu Barda. In his speech, he enumerated the efforts of his government in promoting STM, through the provision of science equipment in Secondary Schools and payment of science allowance to teachers in his state. He also reiterated his government's commitment to the provision of STM education in Katsina State. He donated a handsome sum of money on behalf of the government and people of Katsina State. The address of the STAN President, Prof. U.M.O. Uvowi, FSTAN focussed on "Instructional Competencies". In his address, he stressed the competencies required of STM teachers as:

(i) entry behaviour into the teaching profession;

(ii) the training and retention of teachers, and

(iii) a proper match amongst the elements of teachers, non- teaching staff, students and materials.

The Commissioner for Education, Hajia Rakiya Abdullaziz Jibia delivered a short welcome address while the Principal of Government College, Katsina, Alhaji Rabe Musa Maiadua also presented a welcome address.

4.0 The Keynote Address was presented by Professor Emeritus E.A. Yoloye, FSTAN. His address, supported with relevant data revealed that professional development was not merely professional training in science, technology and mathematics education leading to professional certificates, but was more of broadening the knowledge base, skills and understanding of science of STM personnel. Retention, he stated, dealt with the motivation of the personnel to continue on the job.

5.0 The following sub-themes were discussed:

(a) Professional Development and Retention of Personnel for Effective STM Education in Nigeria: Socio-cultural factors.

(b) Professional Development and Retention of Personnel for Effective

STM Education in Nigeria: Implications for the Learner.

(c) Professional Development and Retention of Personnel for Effective STM Education in Nigeria: Implications for Meaningful National Development.

(d) Professional Development and Retention of Personnel for Effective STM Education in Nigeria: Comparative Analysis.

6.0 Other highlights of the conference.

6.1 **Launching of Books:**
Position Papers 1, 2 and 3, authored and published by STAN were launched during the conference.

6.2 **Conferment of Fellowship of STAN:**
Two distinguished members of STAN namely: Dr R.L.N. Offurum and Mr P.P. Udofia were conferred with FSTAN Award for their invaluable contribution to the Association and science education in Nigeria.

6.3 **Special Lectures:**
Dr Kabir Ahmed, Provost, College of Education (Technical), Dutsin-Ma delivered a lecture entitled "Science Education Today". This lecture focused on:

i. meaning and implications of scientific knowledge;

ii. essence of science education, and

iii. the interaction of science education and society.

Alhaji Is'haq Nuhu, Chairman, Katsina State Implementation Task Force on the National Policy on Education centred his lecture on "Administrative and Financial Factors Affecting the Development and Retention of Personnel for Effective STM Education."

The lecture focused on:

(i) source and supply of STM teachers;

(ii) administrative factors militating against the development and retention of STM teachers.

6.4 **STAN Symposium:**
The theme of the symposium was "Professional Development and Retention of Personnel for Effective STM Education in Nigeria: Contributions from States." Representatives from the following states participated in the symposium: Katsina, Kano, Lagos and Ogun.

6.5 **Science Quiz:**
Cross River State represented by Federal Science College, Ogoja won the first prize of the quiz competition, Katsina State came second while Bauchi State took the third position.

6.6 **Election:**
Mr John Ogu, MSTAN was elected General Secretary of the Association during the conference.

7.0 **Resolution:**
Having deliberated extensively on the theme: Professional Development and

Retention of Personnel for Effective Science, Technology and Mathematics (STM) Education in Nigeria, the conference observed that there was much room for improvement in the professional development and retention of STM teachers and resolved as follows:

7.1 **Commendations:**
STAN commends the Federal Government for:

7.1.1 mounting the Annual Teacher Vacation Course (TVC) for the professional development of STM teachers;

7.1.2 upgrading the Grade II teachers professionally through the NTI Distance Learning System (DLS) to the NCE level, thus encouraging their retention in the teaching profession;

7.1.3 making a deliberate policy for the production of STM teachers;

7.1.4 promulgating an enabling decree for the professionalisation of teaching;

7.1.5 establishing more Federal Colleges of Education (Technical) to produce more teachers of technology;

7.1.6 encouraging computer literacy for STM teachers, educators and administrators.

STAN commends the State Government for:

7.1.7 sponsoring the STM teachers to the annual TVC;

7.1.8 paying science inducement allowances to STM teachers;

7.1.9 encouraging computer literacy for STM teachers, educators and administrators;

7.1.10 institutionalising in-service courses for STM teachers;

7.1.11 providing funds, materials and equipment for STM education.

7.2 **Observations:**
In spite of the commendations listed above, STAN observes that:

7.2.1 teaching of STM subjects still continues to be devoid of innovative teaching strategies:

7.2.2 a high proportion of equipment in school science laboratories and workshops are in bad condition due to poor maintenance culture;

7.2.3 less than 4% of schools subscribe to any journal and STM journals available to STM teachers have drastically reduced;

7.2.4 some Nigerians that were trained under the Technical Teachers Training Programme (TTTP) in the 80's to teach technology have found their way to commerce and industry due to dissatisfaction and lack of incentives;

7.2.5 Discipline in schools today is at a very low ebb;

7.2.6 STM laboratory personnel are few in the secondary schools and non-existent in the primary schools;

7.2.7 problem of inadequate funding, poor conditions of service and loss of morale militate against teacher motivation and desire to remain on the job;

7.2.8 an inter-disciplinary approach to the teaching of STM is desirable, and should be extended to include studies in population/family life education, environmental education, citizenship education, drug abuse education and the like.

7.3.0 **Recommendations:**
STAN therefore recommends that:

7.3.1 Deliberate efforts should be made to train STM teachers in:

(a) group and individual methods of working with students;

(b) greater use of co-curricular activities such as guest lectures, excursions, science fairs and exhibitions;

(c) greater and effective use of home work, assignments and projects.

7.3.2 The provision of laboratories and equipment should be carefully planned and executed so as to effectively support the teaching of science, mathematics and technical subjects.

7.3.3 The curricular of professional training for STM teachers should be broadened to include knowledge of world problems such as population, environ- ment, drugs and peace as well as the wider implication of science such as the philosophies of STM and society.

7.3.4 Proper foundation should be laid for STM education at the primary school level through employing specialist science and mathematics teachers.

7.3.5 The use of non-formal education delivery systems and out-of-school co-curricular activities such as JETS competition should be intensified.

7.3.6 STAN should intensify and formalise its own teacher training efforts and curricula/instructional materials development programme and request government for demonstrable support.

7.3.7 NTI should intensify efforts to operate the section of the decree establishing it which deal with providing teaching with regular in-service training opportunities.

7.3.8 Adequate allocation of funds for Research and Development in Science and Engineering Infrastructure should constitute a land mark in government's national development plans.

7.3.9 The Federal Ministry of Education and Youth Development should put in place the necessary machinery to establish the National Teachers Registration Council.

7.3.10 States that have not started paying science allowance to their STM teachers should do so in order to encourage them.

7.3.11 Incentives for STM personnel should be made vis-a-vis their participation and effective contribution in workshops, conferences and seminars.

7.3.12 Discipline in schools should be stepped up by involving PTAs.

Professor U.M.O. Iwovi, FSTAN
President
21 August, 1993